Supreme Court, U.S.
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No. 06-508

IN THE

Supreme Court of the United States

VAUGHAN COMPANY, INC.,

Petitioner,

v.

LIQUID DYNAMICS CORPORATION,

Respondent.

ON PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

PETITION FOR A WRIT OF CERTIORARI

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QUESTIONS PRESENTED

1. Does the imposition of maximum punitive damages for patent infringement under 35 U.S.C. § 284 constitute a violation of due process when the infringer is punished for conduct wholly unrelated to his state of mind with respect to infringement?

2. When the admissibility of expert testimony is challenged under Federal Rule of Evidence 702, is it proper for the jury to hear that testimony absent a prior ruling from the Judge that the testimony is sufficiently tied to the facts of the case such that it will aid the jury in resolving a factual dispute?

PARTIES TO THE PROCEEDING AND RULE 29.6 STATEMENT

Petitioner is Vaughan Company, Inc., a corporation of the state of Washington. Vaughan has no parent or subsidiary, and no publicly held company owns ten (10) percent or more of Vaughan's stock.

Respondent is Liquid Dynamics Corporation, an Illinois corporation.

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PETITION FOR A WRIT OF CERTIORARI

OPINIONS BELOW

The judgment of the Court of Appeals for the Federal Circuit ("CAFC") was entered on June 1, 2006, and the opinion is reported at 449 F.3d 1209 (2006). (App., *infra*, 1a-33a.) The relevant opinions of the District Court are unreported. (App., *infra*, 34a-131a.) The CAFC denied Panel Rehearing and Rehearing *En Banc*. (App., *infra*, 132a-133a.)

In 2002, Petitioner Vaughan was granted summary judgment of noninfringement by the District Court in an opinion available at 2002 U.S. Dist. LEXIS 14102, July 31, 2002. The CAFC reversed the District Court's claim construction in an opinion reported at 355 F.3d 1361. (Fed. Cir. 2004).

STATEMENT OF JURISDICTION

Judgment of the Federal Circuit was entered on June 1, 2006. On July 11, 2006, the Federal Circuit denied a timely filed Petition for Rehearing. The jurisdiction of this Court is invoked pursuant to 28 U.S.C. § 1254(1).

CONSTITUTIONAL AND STATUTORY PROVISIONS INVOLVED

The Due Process clause of the Constitution, 5th Amendment, provides in relevant part: "No person shall be . . . deprived of life, liberty, or property without due process of law. . . ." U.S. Constitution, Amendment 5.

Title 35 of the United States Code, Section 284 provides in relevant part that the court "may increase the damages up to three times the amount found or assessed."

Federal Rule of Evidence 702 provides in relevant part:

> If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.

Fed. R. Evid. 702 (2000).

INTRODUCTION

The judgment in this matter is genuinely troubling because it levies severe civil penalties against a manufacturer whose conduct was deemed lawful by two out of four federal judges who reviewed the evidence: (1) the district judge and (2) the dissenting member of the CAFC panel. Judgment affirming excessive civil penalties in this case represents a due process violation of the most basic sort. At all times, Vaughan acted in reliance on a reasonable belief that it would not infringe, yet it has suffered severe, quasi-criminal punishment. Vaughan was punished under arbitrary standards, and without reasonable notice that its conduct might be subject to severe punishment.

When Petitioner Vaughan first learned it *might* infringe an issued patent, Vaughan evaluated the patent and its proposed system and obtained opinions from its patent counsel that use of Vaughan's system would not infringe Liquid Dynamics' patent. Vaughan's pre-litigation investigation and analysis was based on a construction of the patent claims that was eventually adopted by the District Court. In ruling on Vaughan's motion

for summary judgment of noninfringement, the District Court applied Vaughan's claim construction to the infringement evidence, and held that "no reasonable person" could find infringement. Vaughan's reliance on this claim construction and its conduct was, therefore, subjectively and objectively reasonable.

After summary judgment in Vaughan's favor, the District Court's claim construction was narrowly overturned by the CAFC, despite a vigorous dissent by Circuit Judge Lourie. *Liquid Dynamics Corporation v. Vaughan Company, Inc.*, 355 F.3d 1361 (Fed. Cir. 2004) (Judge Lourie, dissenting). The case was remanded for a jury trial on the identical evidence; no further discovery was conducted. Based on the CAFC's revised claim construction, the jury concluded that Vaughan *willfully* infringed the patent. Then, notwithstanding its earlier ruling granting summary judgment, the District Court imposed the maximum possible punitive damages, trebling an already excessive compensatory royalty award of 45% of Vaughan's gross sales and further awarding full attorney fees.[1] Final judgment in this case, including punitive damages awarded as a consequence of

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1. 35 U.S.C. § 284 provides for a measure of damages in the amount of a "reasonable royalty for the use made of the invention by the infringer." By any objective standard, a 45% royalty of the infringer's *gross sales* is not "reasonable" when such a percentage would have left the infringer no profit whatsoever on the accused devices. The reasonable royalty measure of damages set forth in 35 U.S.C. § 284 must emulate a percentage that could be achieved through negotiation between the parties. *Interactive Pictures Corp. v. Infinite Pictures, Inc.*, 274 F.3d 1371, 1386 (Fed. Cir. 2001) (citing *GeorgiaPacific Corp. v. U.S. Plywood Corp.*, 318 F. Supp. 1116, 1120 (S.D.N.Y. 1970)). By definition, a royalty percentage that leaves one party with no profit would not be the product of royalty negotiations.

the jury's finding that Vaughan *willfully infringed*, dwarfed the already excessive 45% royalty by more than a 4:1 ratio.[2]

Vaughan was denied due process. Vaughan relied in good faith on its patent counsel's claim interpretation, an interpretation so eminently reasonable that two of the four federal judges who evaluated it pronounced it correct. Vaughan has now been severely punished by the CAFC for conduct that was commercially reasonable by all known objective standards. The CAFC's opinion upholding punitive damages awards under 35 U.S.C. § 284 has entered a zone of arbitrariness that violates due process. At least one judge from the CAFC has openly criticized CAFC law as being directly contrary to this Court's holdings in *BMW of North America, Inc. v. Gore*, 517 U.S. 559 (1996) ("*Gore*"), as well as *State Farm Mut. Auto Ins. Co. v. Campbell*, 538 U.S. 408 (2003). *See KnorrBremse Systeme Fuer*

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2. The jury awarded Liquid Dynamics a compensatory damage award of $1,183,722, an amount equaling (to the dollar) the requested 45% royalty for all 47 accused systems. According to Liquid Dynamics' own financial expert, a 45% royalty eliminated any profits Vaughan could have made on the accused systems. Vaughan moved for remittitur or alternatively for a new trial on damages as well as judgment as a matter of law ("JMOL") on the question of infringement. Both motions were denied immediately upon presentment, without time for meaningful review by the District Court. Adding to an already excessive compensatory award, the District Court added an additional $1,501,239.80 in attorney's fees, bringing the total award with interest and costs to $2,922,772.40. This compensatory award surpassed Vaughan's ***gross*** sales on the 47 accused systems by almost $400,000.

The District Court then trebled damages pursuant to 35 U.S.C. § 284, adding an additional $2,367,444 in punitive damages. Assuming *arguendo* that the "actual harm inflicted" by infringement amounted to $1,183,722 (the excessive 45% "royalty"), the ratio of the overall award, including punitive damages, to the actual harm inflicted was more than 4:1. ($5,290,216.40 total award divided by $1,183,722.)

Nutzfahrzeuge GmbH v. Dana Corp., 383 F.3d 1337, 1348 (Fed. Cir. 2004) (Dyk, J., concurring inpart and dissenting inpart). As further explained below, the patchwork of CAFC decisions enhancing damages for willful infringement pursuant to 35 U.S.C. § 284 provides no reasonable warning of the circumstances normally associated with egregiously improper conduct. This case is an extreme example of a severe, quasi-criminal punishment in the form of grossly excessive sanctions levied by the court in a patent case where the commercial actor had no reasonable opportunity to alter its conduct to avoid punishment.

Moreover, in upholding the infringement verdict, the CAFC has now joined the Court of Appeals for the Eleventh Circuit in adopting a standard for admissibility of expert opinion testimony under Fed. R. Evid. 702 that is contrary to this Court's precedent in *Daubert v. Merrell Dow Pharms.*, 509 U.S. 579 (1993) and *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999). In this case, the CAFC has approved the 11th Circuit holding that so long as an expert claims that he has used an admittedly sound methodology, the District Court need not take any steps to confirm that the testimony is sufficiently tied to the facts of the case in order to aid the jury's resolution of a fact in issue. Instead, under current CAFC and 11th Circuit law, the *jury* decides whether the experts' opinions "fit" the facts of the case under Fed. R. Evid. 702. Absent this Court's intervention, future litigants in patent cases face a flood of expert opinion offered to lay juries on the ultimate issue of infringement, without any judicial evaluation of its helpfulness or "fit" under *Daubert*.

STATEMENT OF THE CASE

A. THE '414 PATENT

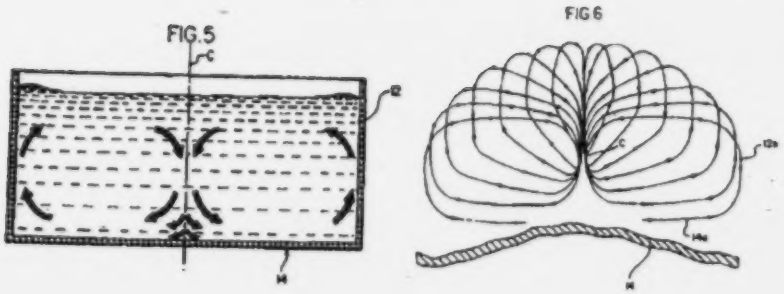
The patent at issue in this case is U.S. Patent No. 5,458,414 ("the '414 Patent" or the "patentinsuit"). The '414 Patent claims an apparatus for storing a "slurry," a mixture of liquid and solid components such as those in waste water and manure treatment systems. The claimed invention includes a storage tank of about one million gallons, combined with a mixing system. Over time, as the slurry components are stored, the solids tend to settle out and accumulate at the bottom of the tank. The claims of the '414 Patent require nozzles ("flow generating means") to be placed at specific radii and orientations, such that the mixing system develops a flow pattern with very narrowly defined characteristics. The required flow pattern is called "substantial helical flow," and according to the claim language of the patent, it must exist at the time the entire body of liquid and solid components is rotating. An excerpt from Claim 1 of the '414 Patent describes the required flow path as follows:

> **Each of said first and second flow generating means being pointed toward the outer surrounding wall for generating a** *substantial helical flow path* **of the liquid and solid components therein with the liquid and solid components** *traveling outwardly, across the tank floor from the center portion of the tank toward the tank wall and then upwardly along the tank outer surrounding wall to a first point and then inwardly along an upper portion of the body toward the center of the tank and then downwardly toward the tank floor, and then outwardly to a second point spaced circumferentially in the direction of rotation of the entire body of liquid, the liquid and solid components continuing to travel in the helical path as the entire*

body of liquid and solid components continues to rotate; . . .

(Supp. App.: '414 Patent, Col. 9, lines 1327 (emphasis added)).

Figures 5 and 6 of the '414 Patent illustrate the flow path claimed:



B. ACCUSED VAUGHAN MIXING SYSTEMS

Vaughan makes and sells customized pump and nozzle combinations for installation in tanks of new construction or for "retrofitting" an existing tank built without a mixing system or having a mixing system that needs replacement. Vaughan's pump and nozzle combinations are intended to mix the tank contents in a simple but effective rotational stirring motion, rotating the contents about a vertical axis centered in the tank, like the swirling motion of stirred tea leaves in a tea cup.

Liquid Dynamics and Vaughan had a vendee/vendor relationship for many years before litigation commenced. Vaughan supplied Liquid Dynamics with an essential element for its own tank mixing systems: a "chopper pump" having internal blades capable of chopping fibrous material passing through the pump, eliminating clogging. The parties' mutually beneficial business relationship soured when Vaughan considered manufacturing a competing mixing system to that offered by Liquid Dynamics, a floor mounted arrangement of nozzles powered by Vaughan's chopper pump.

In February 2000, Vaughan submitted a bid to the city of Augusta, Georgia, for its first floor-mounted mixing system. February 2000 was the first time Vaughan had ever bid in competition with Liquid Dynamics. Vaughan's design for Augusta specified twelve nozzles at six locations, with each nozzle mounted three to eight feet above the floor. Vaughan advised Augusta that its discharge nozzles were designed to mix the tank in a simple rotational manner.

After Vaughan was awarded the Augusta job in June 2000, Liquid Dynamics' president and the named coinventor of the '414 Patent, Mark Crump, met with Vaughan's president. At this June 2000 meeting, Crump "mentioned" the '414 Patent

although he made no express charge of infringement. Within days after this meeting, and well over a year before litigation commenced, Vaughan engaged its patent counsel to investigate the '414 Patent and evaluate potential infringement for the Augusta system. Vaughan provided its counsel with computational fluid dynamics (CFD) studies of the expected flow pattern of the Vaughan floor-mounted mixing design, studies which Vaughan had previously commissioned for reasons unrelated to the '414 Patent.

Relying on Vaughan's CFD information and on Vaughan's unique dual-nozzle design imparting rotational flow about a vertical axis centered in the tank, Vaughan's patent counsel rendered an opinion in early June 2000 (more than a year before any express change of infringement) that the mixing systems described by the CFD simulations did not infringe because they did not produce a "substantial helical flow pattern" as required by the claims of the '414 Patent.

Liquid Dynamics accused 47 different Vaughan installations of infringement. The 47 accused installations at issue include highly different, highly customized designs, often for retrofit into an existing storage tank. There was little uniformity in design among the 47 accused installations. In fact, they comprised 34 discrete configurations, with wide variations in the number of nozzles, nozzle heights, nozzle placements, tank diameters, tank volumes, pump sizing, and other similar parameters. Data regarding the physical parameters for many accused systems—data deemed critical for determining flow pattern by all expert witnesses—were unknown to Vaughan but readily discoverable from third party tank owners. All experts testified that significant variations in nozzle placement, nozzle diameter, nozzle orientation, and nozzle height could result in a material change to the flow pattern, causing the pattern in a given system to be non-infringing.

Liquid Dynamics had the burden to show the presence of the claimed flow pattern in all 47 accused systems, however, it lacked adequate data regarding key physical parameters for each accused system including nozzle height, nozzle orientation, location of the nozzles on the radius, nozzle diameter, among other critical data.[3] In order to bridge this significant gap in the evidence, Liquid Dynamics relied on the expert testimony of Dr. Richard M. Lueptow.

C. SUMMARY JUDGMENT OF NON-INFRINGEMENT AND THE FIRST APPEAL

Liquid Dynamics filed its complaint for infringement on September 10, 2001. Prior to filing its complaint, Liquid Dynamics had engaged an independent vendor to perform a CFD simulation of Vaughan's new system in an effort to ascertain whether the claimed flow pattern was present. Liquid Dynamics' study was for the Vaughan system installed at the City of Merced, California. Unbeknownst to Liquid Dynamics, Vaughan had also commissioned a prelitigation study for its City of Merced mixing system. Both studies—one obtained by Vaughan and the other by Liquid Dynamics—agreed in their conclusions showing simple rotational flow about a vertical axis centered in the tank.

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3. Accurate data necessary to correctly model all 47 accused systems could have easily been obtained by Liquid Dynamics through simple third party discovery directed at the owners of the tanks. Liquid Dynamics failed to conduct the necessary third party discovery, and instead placed the burden upon Vaughan to show what the parameters actually were in all 47 accused systems.

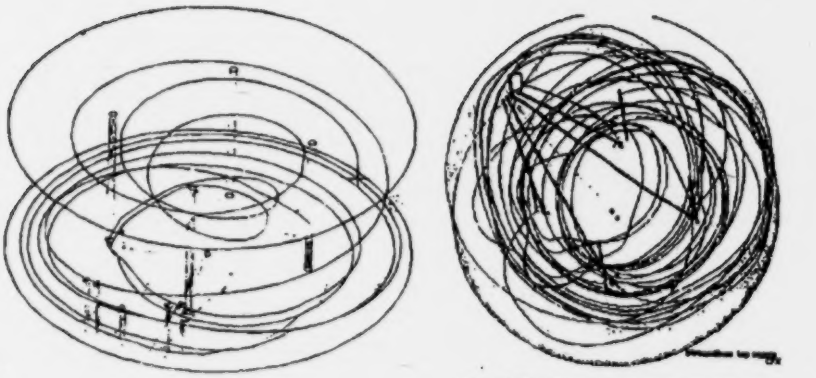

Figure B.7 Streaklines released from top nozzles for dual nozzle configuration - top view

The vendor who supplied both Vaughan and Liquid Dynamics with their respective pre-litigation studies for Merced was called AEA Technologies Inc. ("AEA"). AEA is the vendor of powerful CFD software useful for determining flow pattern. AEA warns all users that the results of CFD analysis "can only hope to approach reality" if real physical parameters are used as input. Liquid Dynamics ignored this warning because it was not concerned with simulating the *actual* flow pattern in the 47 accused systems, it was only concerned with showing an infringing flow pattern.

Up until the deadline for expert reports in the case, April 1, 2002, the only CFD evidence in existence to show flow pattern originated with AEA. All AEA studies agreed in their conclusions: when the flow pattern is shown in a streak line plot, it is ***not*** a "substantial helical flow pattern."[4] On the deadline for disclosure of expert reports, Liquid Dynamics proffered the report of Dr. Lueptow, a professor of mechanical engineering with no prior experience with AEA's sophisticated CFD software. In lieu of expert testimony from one having knowledge regarding operation of the software, AEA offered Dr. Lueptow's opinions—opinions that were limited to "interpreting the results" of several studies done in-house by Liquid Dynamics' young employee, Jared Proctor. Mr. Proctor had no relevant education in CFD, his training amounted to little more than a three day seminar in operation of the software. The results obtained by Proctor (as "interpreted" by Dr. Lueptow) for Vaughan's city of Merced project differed dramatically from those obtained by the accepted experts at AEA as shown below.

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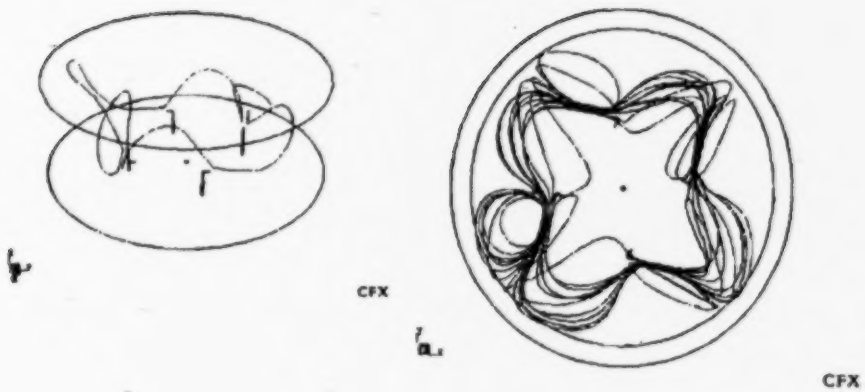
4. Liquid Dynamics argued that other plots in the AEA reports showed helical flow, however these plots were not "streak line" plots and they did not track flow over time. The AEA plots referenced by Liquid Dynamics consisted of irrelevant, two-dimensional "vector plots" having no ability to track the flow over time as the claims require. The CAFC acknowledged that Vaughan's interpretation of vector plots "could be correct" and that vector plots were "subject to different interpretations." (App., *infra*, 22a.) Liquid Dynamics consistently asserted its own (incorrect) interpretation of vector plots from the AEA reports as the sole evidence in support of its case that Vaughan willfully infringed the '414 patent.



Liquid Dynamics' in-house CFD studies for flow pattern were based on just ***nine*** fictitious, allegedly "representative" models.[5]

For the purpose of its summary judgment motion, Vaughan argued that even if these CFD studies were properly executed and even if they were based on models relevant to the 47 accused systems having 37 vastly different sets of physical parameters, the results still did not show the "substantial helical flow path" of the '414 Patent's claims.

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5. Because Liquid Dynamics lacked knowledge of the correct physical parameters for the accused systems, its claims that the nine models were "representative" of the accused systems inherently lack foundation.

By order of July 31, 2002, the District Court granted Vaughan's motion and entered summary judgment holding that on the basis of the Proctor/Lueptow CFD evidence, "no reasonable person" could conclude that any of the 47 accused Vaughan mixing systems developed the claimed "substantial helical" flow pattern. 2002 U.S. Dist. LEXIS 14102. It is worth re-emphasizing that the District Court's finding of non-infringement on summary judgment assumed that all CFD evidence generated, including the AEA studies *and* the Proctor/ Lueptow CFD studies, were reliable and relevant to the question of infringement. Upon the body of this CFD evidence, and its own reasoned interpretation of the '414 Patent's claims (an interpretation agreeing with Vaughan's prelitigation opinion from counsel), the District Court granted summary judgment of noninfringement because the CFD patterns failed to show the existence of "substantial helical flow."

The judgment of non-infringement was appealed to the CAFC. The CAFC narrowly reversed the District Court's claim construction on a 2 to1 decision. *Liquid Dynamics Corporation v. Vaughan Company, Inc.*, 355 F.3d 1361 (Fed. Cir. 2004) (Judge Lourie, dissenting).

D. DISTRICT COURT PROCEEDINGS AFTER REMAND

On remand, the court set a date for trial; no further discovery was had. In preparing its summary judgment motion two years earlier, Vaughan was aware of serious, indeed fatal, flaws in the CFD studies performed in-house by Liquid Dynamics and interpreted by the expert Lueptow. Vaughan sought the court's *in limine* order excluding Lueptow's opinions on the grounds of both reliability and "fit" to the facts of the case. The *in limine* motions were denied, and the expert was permitted to offer his opinions at trial. (App., *infra*, 130-131a.) The District Court

made no determination regarding fit or relevancy of the Lueptow/Proctor opinions to the facts of the case. The District Court's ruling is not based on Fed. R. Evid. 702 but on Rule 26 of the Federal Rules of Civil Procedure, finding the body of Vaughan's *in limine* motion untimely expert opinion. (App., *infra*, 122-129a.) The District Court thus holds that Fed. R. Civ. Pro. 26 in essence "trumps" Fed. R. Evid. 702.[6]

During cross-examination, Liquid Dynamics' expert Lueptow admitted numerous flaws in "his"[7] CFD models. Lueptow acknowledged that a computer model for flow can only "hope" to accurately simulate a real flow situation if the parameters of the computer model corresponds to real physical parameters. Lueptow also admitted that for a large number of the 34 discrete designs, he did not know (and therefore could not accurately model) various critical parameters: tank diameter, tank height, nozzle size, nozzle angle, pump output velocity, and so on. Once again, every expert testified that variations among these parameters could materially affect the flow pattern. Even more remarkably, where Liquid Dynamics' had necessary

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6. The essence of Vaughan's challenge to the admissibility of the Lueptow/Proctor analysis was contained in Vaughan's timelyfiled rebuttal expert report. Even if Vaughan's *in limine* motion rested on additional expert testimony, Fed. R. Evid. 702 requires the Court to exercise its gatekeeping function to make sure expert testimony is both reliable and helpful to the jury prior to being admitted into evidence at trial. The disclosure requirements of Fed. R. Civ. Pro. 26 should not trump the Court's gatekeeping obligation pursuant to Fed. R. Evid. 702.

7. Although he claimed the CFD studies as his own, Dr. Lueptow admitted that the software was operated by Jared Proctor, the young LD employee having only a 3-day seminar's worth of training from AEA. It was not disputed at trial that Dr. Lueptow lacked any CFD training from the software vendor AEA and that the only person trained in operation of the software was LD employee Jared Proctor.

data, Liquid Dynamics used completely different, arbitrary parameters in constructing its computer models.

The differences between the actual parameters and modeled parameters were dramatic. To cite just two of many blatant examples: (1) Liquid Dynamics had a computer model with nozzles ***20 feet lower*** than the actual real world accused tank,[8] and (2) Liquid Dynamics modeled nozzle diameters so inaccurately they modeled ***double the velocity of the flow*** when compared to the velocity known to exist in the real world accused systems. Moreover, Lueptow's trial testimony confirmed that he never tested to determine whether Liquid Dynamics' inaccurate models affected the appearance of the simulated flow. He only offered his *ipse dixit* assurance to the jury that such changes would not alter the "robust" nature of the helical flow pattern. Lueptow's reliance on incorrect physical parameters for the models was directly contrary to AEA's strict admonition of the need to use accurate parameters, lest the result be meaningless.

Even Lueptow's testimony confirmed that the opinions he offered did not fit the facts of the case. The '414 Patent claims require that the helical flow path be present when the entire body of tank contents is rotating. All experts and the inventor testified that rotation of the entire body of tank contents does not occur for at least 30 minutes after flow has been initiated. Because of the enormous volume of these tanks (often exceeding 1,000,000 gallons), the inertia that must be overcome by flow from small jet nozzles is massive. Thus, in order to fit the facts of the case, Lueptow's simulations should have predicted the flow path at a time corresponding to about 30 minutes after pump startup. Flow existing mere seconds after the pump starts

8. Lueptow admitted that placement of nozzles "high" in the tank would create a flow ***opposite*** to the patent's claimed flow.

is utterly irrelevant to predicting what the flow pattern will look like after the pumps have been running for 30 minutes or more, and after the flow conditions have stopped changing. In order to be relevant to the jury's determination of infringement, flow needed to be modeled after the pumps had been running long enough for the flow to reach a "steady state" (*i.e.*, no longer changing because all inertia had been overcome). Otherwise, the testing was utterly meaningless and not helpful to the jury.

On cross-examination, Lueptow admitted that the Liquid Dynamic simulations he relied on were run to a point only a ***few seconds*** after the pumps started, at a time when nearly all of the tank contents in the simulated tank remained at near zero velocity, long before rotation of the entire body of tank contents. Lueptow had submitted a declaration in opposition to Vaughan's *in limine* motion in which he expressed the (erroneous) belief that the patent claims were satisfied if substantial helical flow occurred at any point after the pump startup. It was not until he reviewed the patent claim language on cross-examination that he acknowledged the requirement that helical flow must appear during "entire body rotation" of the tank contents.

By failing to test for flow pattern at the correct time, Lueptow's opinions on infringement were not helpful to the jury because they did not "fit" the facts of this case. The CAFC erred in affirming the District Court's denial of Vaughan's motion *in limine*, incorrectly holding that the jury may hear non-helpful, irrelevant expert testimony so long as it is subject to cross-examination. This Court's precedent in *Daubert* and *Kumho Tire* requires "gatekeeping," or the regulation by the judge of such irrelevant and non-helpful testimony.

Despite astonishing flaws in the relevance or "fit" of Lueptow's opinions, and despite timely motions *in limine* under Evidence Rule 702, the District Court refused to exercise its

gatekeeping obligation, eschewing any evaluation or determination regarding "fit" or helpfulness to the jury. Instead, the question of "fit" or helpfulness was left to cross-examination. Lueptow's testimony was the sole evidence of flow pattern in the accused Vaughan tanks.

Vaughan also made timely motions for JMOL on the issue of infringement, both at the close of the plaintiff's case, at the close of the defense case, and after entry of judgment, explaining the material defects in Lueptow's expert testimony. All Vaughan motions were denied.

E. CAFC'S AFFIRMANCE

1. The CAFC's Decision Is in Direct Conflict With This Court's Precedent

The decision by the CAFC affirmed the District Court's denial of Vaughan's motions *in limine* as well as the District Court's order denying JMOL on the question of infringement, and enhancing damages pursuant to 35 U.S.C. § 284. The CAFC opinion is based on two lines of authority in conflict with the precedent of this Court. First, the decision affirming enhancement of damages was based on *KnorrBremse*, 383 F.3d at 1337, an *en banc* CAFC decision widely criticized as being in conflict with this Court's holdings that punitive damages can only be awarded in situations where conduct is reprehensible. *See, e.g., State Farm Mut. Auto Ins. Co.*, 538 U.S. at 408; *Gore*, 517 U.S. at 559. Second, the decision affirming denial of Vaughan's motions *in limine* and JMOL conflicts with this Court's decisions in *Daubert*, 509 U.S. at 579, and its progeny which require the trial court to consider the reliability of expert testimony, and that the testimony meets the threshold of relevancy, that is, "fit" to the facts of a particular case, pursuant to Fed. R. Evid. 702.

Current CAFC opinion on both of these topics adversely affects the ability of commercial actors such as petitioner Vaughan, to identify conduct sufficiently reprehensible justifying severe civil penalties. The patchwork of CAFC decisions on the issue of willful infringement and enhanced damages provides no guidance to commercial actors to avoid punitive damages, while offering competitive products under a wholly reasonable belief that they do not infringe.

2. The CAFC's Reasons for Affirming Punitive Sanctions in This Case Lack Merit

The District Court levied maximum treble damages against Vaughan, and assessed attorneys' fees as a result of the jury's finding of willful infringement. The jury should not have been permitted to hear argument on willful infringement at all, since Vaughan's conduct was held to be lawful by two out of the four federal judges who evaluated the infringement evidence. At all times, Vaughan was relying on its counsel's reasonable opinion of noninfringement. Based on the willful infringement verdict and "particularly [because of] Vaughan's behavior as a litigant," the District Court enhanced damages pursuant to 35 U.S.C. § 284. Vaughan challenged the District Court's findings of willfulness and argued that it was manifestly improper to punish Vaughan for what the District Court perceived as misconduct occurring in the course of litigation. The CAFC erroneously concluded that Vaughan did not adequately preserve its argument for error in the District Court's reliance on "litigation misconduct" as a justification for punishing Vaughan. The CAFC's conclusion of waiver lacks all merit because Vaughan's position was fully set forth in a footnote, including a citation to CAFC precedent stating that it is improper to punish, as willful infringement, conduct occurring much later during the course of litigation. *See Jurgens v. CBK Ltd.*, 80 F.3d 1566, 157071 (Fed. Cir. 1996).

The only other justification the CAFC gives for affirming the District Court's severe punitive damages award is that Vaughan may have "copied" drawings in connection with the Augusta, Georgia project. (App., *infra*, 29a-30a.) Vaughan believed in good faith that its Augusta system would not produce the key novel feature of the '414 patent claims, "substantial helical flow." Thus, even if Vaughan "copied" drawings or other aspects of the Augusta system, it did so with a good faith belief that it was noninfringing. The CAFC's opinion punishes Vaughan for conduct wholly unrelated to infringement. Further, the CAFC's opinion seeks to punish Vaughan for perfectly lawful reverse engineering under the guise of "copying."

The CAFC failed to adequately evaluate whether it would be appropriate to punish a party like Vaughan, who believed in good faith that its conduct was lawful. Furthermore, the CAFC's reasoning is inadequate because it fails to properly evaluate the closeness of this particular case and the fact that two out of the four federal judges who evaluated the infringement evidence found no reasonable argument for infringement.

3. The CAFC's Reasons for Affirming the District Court's *in limine* Order Lack Merit

The CAFC joins the 11th Circuit in finding that expert testimony may properly go to a jury even though it has been challenged under Evidence Rule 702 and there has been no determination whether the particular testimony "fits" the facts of the case. In this case, the CAFC rules that the question of "fit" or helpfulness to the jury is a matter for cross-examination. (App., *infra*, 20a.) In particular, the CAFC recognized that Lueptow's models were inaccurate but that "a reasonable juror could consider Lueptow's testimony explaining the very robust, helical flow in the [incorrect] models and infer that the similar accused tanks will produce flow similar to the modeled flow."

(App., *infra*, 20a.) The CAFC's holding is tantamount to a refusal to determine whether the modeled parameters were indeed "similar" to the accused tanks. The evidence belies any conclusion that the modeled tanks were "similar" to the accused tanks in terms of physical parameters, like flow rates, nozzle diameter, nozzle placement, etc. The tanks modeled by Lueptow bore no "similarity" to the actual accused systems, Liquid Dynamics simply lacked critical data to make any meaningful "representative" model. Absent true data on the accused tanks, any conclusion that the fictitious models are "similar" inherently lacks foundation.

REASONS FOR GRANTING THE PETITION

A. CAFC LAW ON WILLFUL INFRINGEMENT AND ENHANCED DAMAGES PURSUANT TO 35 U.S.C. § 284 IS IN CONFLICT WITH SUPREME COURT PRECEDENT AND VIOLATES DUE PROCESS

Due Process requires that punitive damages be imposed only for conduct that is genuinely egregious and reprehensible. *Gore*, 517 U.S. at 559. Due process also requires adequate notice that certain conduct may be subject to civil punishment. *Id.* Under the CAFC's view, as articulated in the decision below, a company like Vaughan, who obtains a timely opinion from patent counsel construing the claims of a competitor's patent, and on the basis of that claim construction reasonably believes that it does not infringe, may still be punished as a "willful infringer," regardless of whether the punishment is related to infringement. The CAFC failed to articulate (because it could not) reasons why Vaughan's conduct was in willful violation of Liquid Dynamics' patent rights. Instead, the CAFC (like the District Court before it) identified various reasons why Vaughan was punished under § 284, however, none of these reasons relate to Vaughan's state of mind with respect to infringement. If an

accused infringer can be punished severely for conduct *unrelated to infringement*, the CAFC's administration of punitive damages under § 284 has entered a zone of arbitrariness constituting a due process violation. *Gore*, 517 U.S. at 559.

Vaughan engaged in no reprehensible infringing conduct. The District Court's order enhancing damages was based primarily on "Vaughan's behavior as a litigant," however, this conduct was attributable to Vaughan's lawyers and could not possibly serve to punish Vaughan under § 284. The CAFC categorically refused to review the District Court's reasoning underlying its judgment enhancing damages. Vaughn had argued that it would be improper to punish it under § 284 for the conduct of its lawyers, citing Federal Circuit precedent in support of this rule. *See, e.g., Jurgens v. CBK Ltd.*, 80 F.3d at 157071. The order enhancing damages—according to its own terms—was primarily based on "litigation misconduct," not for any conduct relating to infringement. The District Court acted outside of the congressional authority for enhancing damages under 35 U.S.C. § 284 and the CAFC failed to correct this mistake, affirming its view that one accused of patent infringement may be punished under § 284 for conduct *wholly unrelated to infringement.*

With the District Court's primary justification for enhancement ("litigation misconduct") ineffective, the CAFC struggled to find other conduct worthy of a severe sanction of over $2.4 million. The CAFC settled on evidence it held would support a jury finding that Vaughan "copied" the drawings of Liquid Dynamics' proposed installation at Augusta, Georgia. In June 2000, when Vaughan allegedly "copied" Liquid Dynamics' engineering drawings for the Augusta project, Vaughan believed the flow pattern created by its version of the Augusta system was non-helical. Further, Vaughan obtained CFD evidence confirming this belief. Vaughan eventually won summary judgment of noninfringement for the Augusta system,

the same system Vaughan allegedly "copied." The CAFC's reliance on evidence of purported "copying" is insufficient to support a punitive sanction because Vaughan reasonably believed it was acting lawfully.

The CAFC's final justification for affirming the District Court's award enhancing punitive damages against Vaughan rests on a fundamental misapprehension of the evidence. The CAFC finds that Vaughan's opinion of counsel could have properly been discredited due to the fact that counsel was not provided with all relevant CFD drawings, including a vertical vector plot. (App., *infra*, 30a.) The CAFC stated that "patent counsel was advised that the vertical [vector] plots did not show anything of significance." (*Id.*) According to the CAFC, "the jury could use such a concealment of evidence from the attorney to discount the opinion." (*Id.*, citing *Goodwall Construction Co. v. Beers Construction Co.*, 991 F.2d 751, 758 (Fed. Cir. 1993)). Contrary to the CAFC's conclusions of "concealment," the evidence allegedly "concealed" consisted of ***vertical vector plots***, evidence the panel recognized could be "subject to different interpretations." Indeed, the CAFC concluded that "Vaughan's interpretation [of vertical vector plots] *could be correct*." (App., *infra*, 22a, emphasis added.) If, as the CAFC concludes, Vaughan concealed vertical vector plots from its patent counsel, it should not have made any difference in counsel's opinion. This last reason for affirming the District Court's $2.4 million punitive damages award is simply devoid of merit.

1. The CAFC's Requirement That an Accused Infringer Exercise "Due Care" in Order to Avoid Willful Infringement and Enhanced Damages is Inconsistent With Supreme Court Precedent

According to current CAFC law, "where . . . a potential infringer has actual notice of another's patent rights, he has an affirmative duty to exercise due care to determine whether or not he is infringing." *KnorrBremse*, 383 F.3d at 1348 (quoting *Underwater Devices Inc. v. Morrison-Knudsen Co.*, 717 F.2d 1380, 1389 (Fed. Cir. 1983)). At least one judge from the CAFC recognizes that there is "a substantial question as to whether the due care requirement is consistent with the supreme court cases holding that punitive damages can only be awarded in situations where the conduct is reprehensible." *KnorrBremse*, 383 F.3d at 1348 (J. Dyk concurring in-part and dissenting in-part) (citing *State Farm*, 538 U.S. at 408; *Gore*, 517 U.S. at 559). Judge Dyk of the CAFC writes that "enhancing damages for failure to comply with the due care requirement cannot be squared with [*State Farm* and *Gore*]. . . ." *Id.* The CAFC has often recognized that enhanced damages awarded pursuant to 35 U.S.C. § 284 is a form of punitive damages. *KnorrBremse*, 383 F.3d at 1348 (citing *Sensonics, Inc. v. Aerosonic Corp.*, 81 F.3d 1566, 1574 (Fed. Cir. 1996)). The purpose of punitive damages is to punish "reprehensible behavior." Enhancement of damages requires "a showing of willful infringement or other indicium of bad faith warranting punitive damages." *Sensonics*, 81 F.3d at 1574; *see also, Nat'l Presto Indus., Inc. v. West Bend Co.*, 76 F.3d 1185, 1192 (Fed. Cir. 1996) ("liability for willfulness of infringement turns on considerations of intent, state of mind, and culpability."); *see also, Beatrice Foods Co. v. New England Printing and Lithography, Co.*, 923 F.2d 1576, 1579 (Fed. Cir. 1991) ("under our cases, enhanced damages may be awarded only as a penalty for an infringer's increased culpability, namely, willful infringement or bad faith.").

This case decidedly lacks any evidence of "increased culpability" or "bad faith" on the part of Vaughan. The evidence relied on by the CAFC finding that Vaughan "copied" certain drawings related to the Augusta project is of no moment because Vaughan reasonably believed that the Augusta system would exhibit a *noninfringing flow pattern*, a belief shared by the District Court on summary judgment and later by Judge Lourie of the CAFC in his dissent. Both judges believed that this allegedly "copied" system (*i.e.*, Augusta) was noninfringing. Thus, any evidence that Vaughan behaved in bad faith by "copying" the Augusta system is insufficient to support an award of punitive damages because it does not show "increased culpability" or "bad faith" conduct related to infringement. *See, e.g., Beatrice Foods*, 923 F.3d at 1579. Further, the District Court's findings of "litigation misconduct" cannot serve to punish Vaughan, because this conduct is attributable only to Vaughan's attorneys. Finally, the CAFC's determination that Vaughan withheld vertical vector plots from its patent counsel cannot serve to further support the jury's finding of willful infringement because according to the CAFC, vertical vector plots are "subject to different interpretations" and Vaughan's "interpretation [of vertical vector plots] could be correct." (App., *infra*, 22a.)

The CAFC's decision affirms an interpretation of 35 U.S.C. § 284 that permits arbitrary punishment for *any* conduct, no matter how tangential the conduct may be to infringement. Conduct punishable under § 284 must be related to infringement, lest that statute be unconstitutional for violating due process.

2. CAFC Decisions on Willful Infringement and Enhanced Damages Fail to Supply Required Notice Pursuant to the Due Process Clause as to the Type of Conduct Sufficiently Egregious to Justify Punitive Sanctions

After the CAFC's decision in this case and the *en banc* holding in *KnorrBremse*, an individual accused of patent infringement has absolutely no ability to predict, within constitutionally required certainty, whether its conduct may be subject to severe civil sanctions. In this case, Vaughan obtained summary judgment in its favor on the question of infringement, yet it was still burdened with some of the most severe civil penalties levied in a patent case. Vaughan did everything a reasonable company could do under the circumstances in order to avoid a severe civil penalty. Under current CAFC law, the administration of punitive sanctions for willful infringement violates due process because litigants are without reasonable warning of the type of conduct deemed reprehensible by the court. This case demonstrates punishment against a commercial actor who had objectively good faith reasons to proceed as it did. Under current CAFC law, the state of mind of the infringer is of no moment. Any bad conduct, no matter how tangentially related to the question of infringement, may justify punitive sanctions under § 284. Under current CAFC law, even behavior of the litigants' lawyers may justify punishment under § 284.

3. The CAFC's Enhancement of Damages in This Case is Grossly Excessive, Violating Vaughan's Right to Due Process

The amount of damages attributable to the finding of willful infringement is grossly excessive under this Court's precedent in *Gore* and *State Farm Ins. Co.* By any objective standard, the District Court's compensatory award is already severe, making

the addition of maximum punitive damages and attorney's fees wholly improper and in violation of this Court's precedent in *State Farm Ins. Co.* and *Gore*. This is particularly true when the CAFC and the District Court found no evidence of bad faith *infringement*. Any conduct remotely considered "bad faith" was unrelated to Vaughan's infringement in this case. The CAFC's opinion is fundamentally flawed in finding that Vaughan "copied" the invention at Augusta where that same Augusta system was found to be noninfringing on summary judgment. Vaughan had a reasonable belief that what it was doing at Augusta back in June 2000 was not "copying," but creating an improved system that did not present the claimed flow pattern. In a case like this, where there exists absolutely no evidence of bad faith infringement, *severe* maximum civil penalties are in violation of due process.

B. THE COURT SHOULD RESOLVE A SPLIT AMONG THE CIRCUIT COURTS ON THE JUDGE'S ROLE IN EVALUATING THE ADMISSIBILITY OF EXPERT TESTIMONY

1. A Split of Authority Exists on the Interpretation of Federal Rule of Evidence 702

In the years since this Court's decision in *Daubert*, 509 U.S. at 579, a clear split has developed among the circuits as to what role the trial judge should play in passing upon the admissibility of proffered expert testimony pursuant to Evidence Rule 702 of the Federal Rules of Evidence. In *Daubert*, the Supreme Court set forth four factors for district courts to consider when evaluating the validity and relevance of scientific evidence. These factors include (1) whether the methodology can and has been tested, (2) whether the methodology is subject to peer review, (3) the potential rate of error, and (4) the general acceptance of the methodology.

What is the trial judge's role when a party challenging proffered expert testimony agrees that a certain scientific analysis is sound if properly applied, but flaws in the expert's execution of the analysis make it clear that sound scientific techniques were not employed? As this Court has explained, "[t]he objective of [*Daubert*'s gatekeeping requirement] . . . is to make certain that an expert . . . employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field." *Kumho Tire*, 526 U.S. at 152. The great majority of the regional circuits hew very closely to that line, demanding intellectual rigor from the expert. The amendment to Evidence Rule 702 adopted in the year 2000

> specifically provides that the trial court must scrutinize not only the principles and methods used by the expert, but also *whether* those principles and methods have been properly applied to the facts of the case. As the court noted in *In re Paoli RR Yard PCB Litig.*, 35 F.3d 717, 745 (3d Cir. 1994), "*any* step that renders the analysis unreliable . . . renders the expert's testimony inadmissible. *This is true whether the step completely changes a reliable methodology or merely misapplies that methodology.*"

Federal Rules of Evidence 702, Advisory Committee Notes, 2000 Amendments (emphasis in original).

The 3rd Circuit rule articulated in *Paoli RR Yard* is followed in other circuits: The proponent of the expert testimony must not merely claim that it is based upon a reliable methodology, but must show to the satisfaction of the trial judge that the expert has not misapplied the methodology. Note, for example, the rule in the Court of Appeals for the 7th Circuit, which demands proof that the expert "is being as careful as he would be in his regular professional work outside his paid litigation consulting." *Sheehan v. Daily Racing Form Inc.*, 104 F.3d 940, 942 (7th Cir.

1997). An expert's opinions must also have a basis in established fact, and cannot be premised on mere suppositions. *McLean v. 988011 Ontario, Ltd.*, 224 F.3d 797, 800801 (6th Cir. 2000). This standard echoes this Court's opinion in *General Electric Co. v. Joiner*, 522 U.S. 136, 146 (1997), forbidding an expert from offering an opinion based on unwarranted extrapolation from known data: The trial judge "may conclude that there is simply too great an analytical gap between the data and the opinion proffered."

Decisions of the Federal Circuit prior to the opinion below also demanded a very high level of intellectual and scientific rigor, particularly in a case where a computer simulation was employed to show that an accused product met a patent's claim limitations. "There is nothing inherently unreliable or suspect about computer simulations as evidence. But every simulation of a physical process embodies at least some simplifying assumptions, and requires both a solid theoretical foundation and realistic input parameters to yield meaningful results. Without knowing these results, a court cannot evaluate whether the simulation is probative. . . ." *Novartis Corp. v. Ben Venue Labs Inc.*, 271 F.3d 1043, 1054 (Fed. Cir. 2001).

2. The 11th Circuit Has Adopted an Improper Standard, a Standard Relied on by the CAFC in the Opinion Below

The 11th Circuit, and now the Federal Circuit by virtue of the opinion below, has considerably relaxed that standard of intellectual rigor. In the case of *Quiet Tech DC8, Inc. v. HurelDubois UK Ltd.*, 326 F.3d 1333, 134344 (11th Cir. 2003), the appellant challenged the credibility of CFD analysis in the modeling of aerodynamic properties in a jet engine. The expert had used incorrect data and had not assembled sufficient data to run the CFD software, and used the incorrect equations to run his CFD analysis of the engine's aerodynamic properties.

The appellant admitted, however, that a properly employed and properly executed CFD analysis would yield reliable results. The court held that those challenges went to the weight the jury should accord the expert's testimony, and not its admissibility. "The identification of such flaws in generally reliable scientific evidence is precisely the role of cross-examination." *Id.* at 1345. In the 11th Circuit's relaxed standard, therefore, so long as an expert claims to be using an admittedly reliable methodology, flaws in the actual application of the methodology are referred to the jury rather than the trial court.

This standard is inconsistent with this Court's opinions in *Daubert* and *Kumho Tire*, both of which require the court to perform a gatekeeping function to assess not only the reliability of the methodology used by the expert but also the relevancy, the fit to the facts, of the testing underlying expert opinions.

CONCLUSION

This Court's intervention in issuing a writ of certiorari will not merely present the opportunity to overturn an unjust decision, it will review the standard for imposition of punitive damages in a patent infringement matter. A company that has relied on a claim construction so well reasoned as to be approved by the District Court and a minority of the CAFC panel cannot be held to have acted egregiously in disregard of another's patent rights. This is particularly true when, on the reasonable claim construction, "no reasonable person" would conclude that the accused products infringe, as the District Court ruled in its initial summary judgment.

This Court's writ of certiorari will also provide much needed guidance to courts faced with the task of determining whether to admit expert opinion based on computer simulations as proof of patent infringement. Petitioner respectfully requests that the petition be granted.

Respectfully submitted,

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APPENDIX

APPENDIX A — OPINION OF THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT DECIDED JUNE 1, 2006

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

05-1105, -1325, -1366, -1399

LIQUID DYNAMICS CORPORATION,

Plaintiff-Appellee,

v.

VAUGHAN COMPANY, INC.,

Defendant-Appellant.

DECIDED: June 1, 2006

Before GAJARSA, DYK, and PROST, *Circuit Judges*.

GAJARSA, *Circuit Judge*.

This is the second time we have heard an appeal in this case. In the previous appeal, Liquid Dynamics ("LD") contested the claim construction and summary judgment of non-infringement entered against it. *Liquid Dynamics Corp. v. Vaughan* Co., 355 F.3d 1361 (Fed. Cir. 2004) ("*LD I*"). In that decision, we found error in the district court's claim construction, vacated the grant of summary judgment, and remanded for proceedings based on the revised claim construction. *Id.*

Appendix A

On remand, the district court held a six-day jury trial to determine whether Vaughan Company, Inc. ("Vaughan") infringed claims 1 and 8 of U.S. Patent No. 5,458,414 ("the '414 patent") and whether the '414 patent was valid. On October 25, 2004, the jury returned a verdict that Vaughan had infringed the '414 patent, that the infringement was willful, and that Vaughan failed to prove that the '414 patent was invalid. The jury awarded damages to LD in the amount of $1,183,722.

Subsequently, the district court held a bench trial on Vaughan's allegation of inequitable conduct, but granted LD's motion for judgment as a matter of law on that issue at the close of evidence. Final judgment was entered on November 15, 2004, and the district court subsequently denied Vaughan's judgment-as-a-matter-of-law ("JMOL") and new-trial motions on the issues of invalidity, infringement, and willfulness. Thereafter, the district court granted, in part, LD's motions for enhanced damages and attorney's fees. The court trebled the jury's damage award based upon the jury's willfulness finding and "Vaughan's behavior as a litigant." Separately, the court awarded attorney's fees amounting to $1,501,239. The court also entered a permanent injunction on February 25, 2005.

Vaughan now appeals the district court's denial of its JMOL motion for non-infringement, invalidity, no willful infringement, and unenforceability due to inequitable conduct. Further, Vaughan appeals the district court's orders for a permanent injunction, enhanced damages, and attorney's fees. For the reasons stated below, we affirm the judgment of the district court.

Appendix A

I. BACKGROUND

The '414 patent involves a system of pumps that stir mixtures of solids and liquids in large 1,000,000-gallon tanks. The invention is primarily directed to applications for mixing wastewater and manure. Because we have already detailed the invention and its background in *LD I*, we reproduce only a summary of the relevant facts below:

> This case involves the structure of slurry tanks. Slurry tanks are used to store and process chemicals and organic waste products (e.g., manure) that retain value as useful inputs (e.g., fertilizer) into other processes. Large storage tanks house these waste compounds in liquid or semisolid form between their production and their subsequent use. The liquid and solid components of these waste compounds tend to separate when stored, with solid particles either forming a crust on the top of the tank and/or falling to the bottom of the tank. Productive use of the stored compound requires remixing both to suspend the heavy solid particles within the liquid and to ensure that the resulting suspension is uniform. One standard approach has been to stir the mix continuously to avoid settling. Because continuous mixing can be expensive, however, tank designers sought ways to store the mixtures in a still tank, to allow the settling to occur, and to remix only when necessary for use. The '414 patent addressed these concerns.

LD I, 355 F.3d at 1363.

Appendix A

A. *The '414 Patent*

Claims 1 and 8 are the contested claims in this case. The patent recites a method and apparatus for handling wastewater slurries: a storage tank equipped with submerged agitators capable of generating a flow of liquid throughout the tank. With the relevant language underlined, claim 1 reads:

> 1. Apparatus for storing a slurry having solid and liquid components, comprising:
>
> a storage tank defining a volume for holding a body of liquid and solid slurry components, including a floor of generally circular configuration and having a center, said storage tank further including an outer surrounding wall positioned generally at a radial distance from the center;
>
> at least two flow generating means positioned to be submerged within the liquid and solid slurry components for generating flow of at least one of the slurry components along a *rotational direction,* each of said flow generating means being disposed at distances from the center ranging between approximately 30 percent and 70 percent of said radial distance;
>
> each of said first and second flow generating means being pointed toward the outer surrounding wall for generating a *substantial helical flow path*

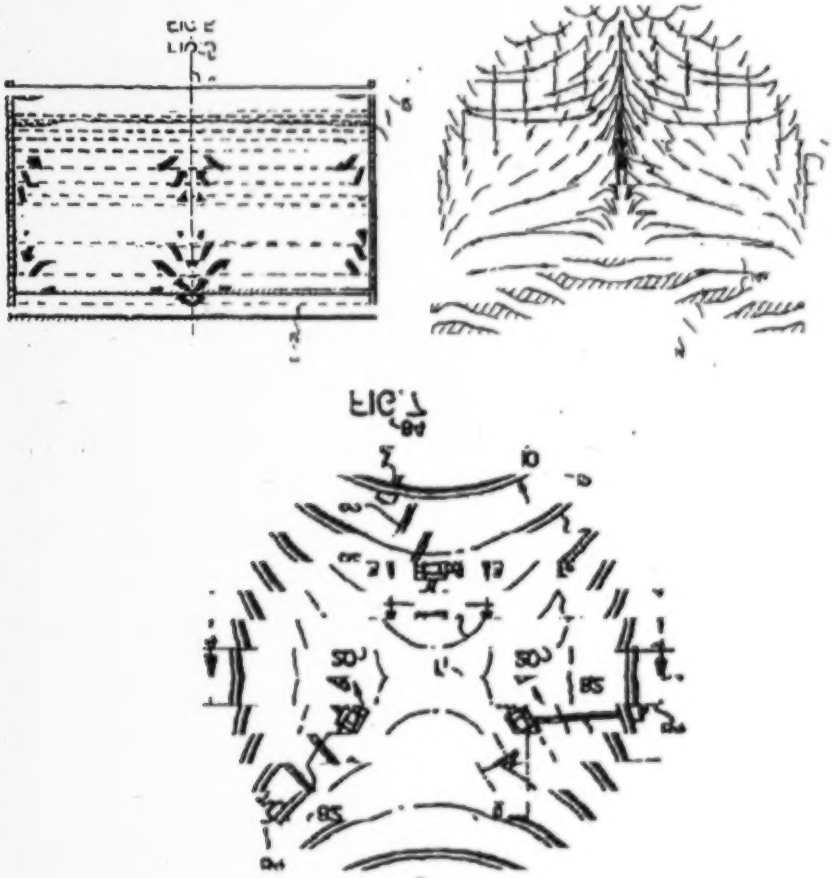
of the liquid and solid components therein with the liquid and solid components traveling outwardly, across the tank floor from the center portion of the tank toward the tank wall and then upwardly along the tank outer surrounding wall to a first point and then inwardly along an upper portion of the body toward the center of the tank and then downwardly toward the tank floor, and then outwardly to a second point spaced circumferentially in the direction of *rotation of the entire body of liquid,* the liquid and solid components continuing to travel in the helical path as the entire body of liquid and solid components continues to rotate;

a pressure source coupled to the first and second flow generating means to generate directed streams from the flow generating means to *rotate the body of liquid and solid components and to cause the flow in the helical path;* and

said flow generating means creating a *substantially volume filling flow* of at least one of the slurry components within said storage tank which mixes the liquid and solid slurry components to form a substantially homogeneous slurry suitable for unloading from said storage tank using liquid handling devices.

'414 Patent, col. 8, l. 56 - col. 9, l. 39 (emphases added). In *LD I,* we construed the term "substantial helical flow" to be "all flow patterns that are generally, though not necessarily

perfectly, spiral, and that fill much, though not necessarily all, of the tank's volume." LD I, 355 F.3d at 1369. Claim 8 includes the relevant terms from claim 1. The written description includes the following examples of tank arrangement and helical flow path.



In Figure 7, impellers or pumps 20 that are placed within the claimed radii of r_1 and r_2 create the substantial helical flow as shown in Figures 5 and 6.

Appendix A

B. *Prior Art and Pre-filing Activities*

The inventors named in the '414 patent, James M. Crump and Bruce K. Doyle, Jr., were dealers for the A.O. Smith Corporation ("A.O. Smith") and sold A.O. Smith's tank agitation system containing a single, center-mounted, rotatable agitator nozzle, known as the Slurrystore system. According to Crump, in 1990 the inventors first became involved with the Slurrystore system when A.O. Smith asked them to help move a tank from a farm to a wastewater treatment plant in Plymouth, Indiana.

Commonwealth Engineering, Plymouth's engineering firm, redesigned the tank for use in the wastewater plant by moving the original agitator away from the tank center and adding a second agitator that was placed on the same radial line on the same side of the tank. The first and second agitators were placed at a distance of approximately 25 and 75 percent respectively, from the tank's center to the wall. The nozzles were designed to rotate in position so that the workers could agitate different sections and clean out the tank when needed. According to Crump, this new design did not help the mixing because the tank slurry was still only agitated in zones and not throughout the whole tank. At startup, the Plymouth tank did not operate properly until flow reducers were installed on the nozzles to impart more energy into the liquid volume. LD presented a video tape made in January of 1992 showing that flow occurred in only one section of the Plymouth tank and not the entire tank.

In the summer and fall of 1991, Crump and Doyle designed and sold the next relevant tank system to a hog

processing plant called Indiana Packers. LD claims the Indiana Packers tank was the same as the Plymouth tank and did not embody the invention claimed by the '414 patent. Crump's diagrams and testimony suggest that the Indiana Packers tank was similar in layout to Plymouth and, like Plymouth, only mixed the liquid in zones.

In April of 1991, the inventors submitted a proposal to A.O. Smith asking that a patent application be filed for their invention for zone mixing within the Indiana Packers and Plymouth tanks. A.O. Smith declined to develop the proposal because it appeared that the invention, as described, was not patentable. Crump testified that in February of 1992, he and Doyle began to develop the idea for mixing throughout the entire tank volume instead of just mixing in one zone at a time, as the Plymouth and Indiana Packers designs provided. The '414 patent, incorporating the concept of volume-filling flow, was filed on May 7, 1992. Although the original application did not claim a substantially helical flow path, it was later amended to claim such a flow path.

Crump further testified that on May 20, 1991 he Offered to sell another system for antibiotic industrial waste to Eli Lilly just after the critical date. According to Crump, the Eli Lilly system was not only offered after the critical date, its nozzle placement was not even within the limitations of the patent. At the time the patent was filed, the Plymouth, Indiana Packers, and Eli Lilly tanks had been installed.

Appendix A

C. *Infringement Evidence*

1. Vaughan's Business History

Vaughan designs and manufactures "chopper pumps," which are used to mix solid materials in large tanks. It claims to have supplied LD with pumps for many years. Vaughan also claims that it was in the business of large-tank mixing designs, decades before the '414 patent, with its roof-mounted chopper pump design called "Scumbuster."

Vaughan and LD's relationship soured when Vaughan began manufacturing floor mounted systems and bid on a tank for the city of Augusta, Georgia. LD claims to have been negotiating with Augusta in late 1999 to supply Augusta with its Jetmix system, the commercial product covered by the '414 patent. In December of 1999, LD terminated Richard Behnke, a sales engineer who had been "intimately involved" with the Augusta design and negotiations. Soon thereafter, Behnke was hired by Vaughan and submitted engineering drawings for nozzle layouts to Augusta, which Vaughan presented as its Rotamix System. LD claims these drawings were directly copied by Behnke from LD's previous engineering drawings. LD also includes statements from Glenn Dorsch, Vaughan's Chief Engineer and Vice President, stating:

> What is planned and requested is for us to remove the [LD] JetMix nozzles from the drawings and put in our own floor mounts. . . . This should be very easy for Wade to do, once we get final orientations from Rich Behnke.

Vaughan notes that even though the nozzles were located in the same place, they constituted a special dual-nozzle design. Thus, whereas the LD Jetmix design had six nozzles, Vaughan's design had twelve.

2. Vaughan's Business Records as Infringement Evidence.

LD confronted Vaughan with allegations of infringement of the '414 patent, and in June of 2000, Vaughan consulted with patent counsel to evaluate the '414 patent and Vaughan's potentially infringing Rotamix design. At about the same time, Vaughan commissioned AEA Technology to perform two different computational fluid dynamics ("CFD") studies to analyze the flow patterns in its tanks. The first study, labeled PX20, evaluated a generic 50-foot-diameter tank that was 30-feet high. The second, labeled PX19, was a study conducted for a proposed tank at Merced, California that demonstrated the tank's mixing capabilities to the city's engineer. Dorsch testified that these studies were representative of the flow patterns generated by Vaughan's Rotamix systems.

Vaughan provided patent counsel with these studies to assist in forming an opinion relative to infringement. Based on the CFD studies and the tank designs, patent counsel rendered an opinion for Vaughan concluding that its Rotamix design did not infringe the '414 patent because it did not produce substantially helical flow.

LD relies on Vaughan's CFD studies as evidence of both infringement and willfulness. The report not only shows

toroidial[1] flow in the vertical plane with downward velocity in the center of the tank and upward velocity at the walls of the tank, but it also indicates there was a "concern over terrodial [sic] flow." Moreover, as LD notes, the author of the PX20 report explained that "the momentum from the nozzles pushes the fluid to the side walls of the tank" and "then changes direction and heads up the side walls." LD's own expert, Lueptow, relied on these same vertical vector plots to express a similar opinion that Vaughan's tanks generate helical flow.

3. Structure Evidence

Next, LD relies on testimony regarding the structure of Vaughan's designs and their similarity to the '414 patent claims. Dorsch, Vaughan's chief engineer and its technical expert at trial, testified that the Vaughan engineering manual included specifications and drawings showing Vaughan's regular method of installation. Vaughan did not keep accurate records of each of the 47 allegedly infringing installations. LD's technical expert Gillette, a wastewater treatment engineer, reviewed the engineering records for all of the accused systems, prepared a report establishing the parameters of each installation, and testified regarding the systems and any missing installation data.

Vaughan correctly points out that Gillette's report lacks nozzle placement and/or nozzle angle data for 11 of

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1. Webster's defines "toroidal" as "of, relating to, or shaped like a torus or toroid: doughnut-shaped." *Webster's Ninth New Collegiate Dictionary* 1245 (1985). The meaning of torodial is similar, if not identical, to helical flow for our purposes.

the 47 systems. However, Dorsch testified that if records on construction were missing it would be reasonable to assume that the installation was in accordance with the standard procedure described in Vaughan's engineering manual.

4. LD's CFD Analysis

LD contends that 47 Vaughan installations infringe the '414 patent. Since some installations are duplicates, there are 34 unique tank designs. Of these, Vaughan argues that there is insufficient evidence to prove that two contested claim elements are present in the accused tanks, namely "substantial helical flow" and "rotation of the entire body." In addition to Vaughan's business records and its own CFD analysis, LD relies heavily on Lueptow's expert opinion. His opinion concludes that each of the 47 installments infringe by recreating the substantially helical flow path. LD supports Lueptow's conclusions with the following evidence in the record: (1) Vaughan's two CFD studies for the generic 50-foot and Merced tanks; (2) LD's prelitigation CFD study modeling the Merced tank; (3) observation of a tank in Argos, Indiana; and (4) Lueptow's own CFD analysis of nine tank configurations representative of various Vaughan installations.

Lueptow performed his own CFD analysis of the Vaughan systems using the same software Vaughan had used in its own CFD studies; however, he did not recreate each of the 47 tanks at issue in this case because CFDs are very time intensive. Instead, he modeled the flows in nine representative tanks with various tank sizes and nozzle configurations depending on different Vaughan designs.

Appendix A

Lueptow based these models on the Vaughan Engineering Manual and Gillette's testimony. Gillette had testified that there was information missing in the record detailing some tank characteristics but that he nonetheless had sufficient information to summarize the tank characteristics for flow modeling.

Lueptow's CFD work resulted in 116 different graphical plots consisting of path-line and vector plots. The vector plots detailed the overall flow path and magnitude in the horizontal and vertical planes. The path-line plots estimated the path an individual particle travels within the tank. Lueptow concluded that the Vaughan systems were very robust and would produce the helical flow despite small changes to each tank. He opined that his representative systems and tanks allowed him to render an opinion on all 47 tanks. This opinion, based on the nine CFD models Lueptow created, the Vaughan data from Merced and a generic 50-foot tank, and LD's Merced Model, was that infringing helical and volume-filling flow is present in all 47 models.

During trial, Vaughan challenged Lueptow's analysis maintaining that the plots simulated conditions just mere seconds after pump startup and that this could not be sufficient evidence of helical and rotational flow during steady-state flow. Lueptow, however, testified that his models were sufficient to determine that helical and rotational flow existed despite the fact that only 40 to 50 iterations were performed.

Appendix A

II. DISCUSSION

A. *Standard of Review*

We review the denial of a JMOL *de novo*. *Juicy Whip, Inc. v. Orange Bang, Inc.*, 292 F.3d 728, 736 (Fed. Cir. 2002). Upon review, we consider whether the jury verdict is supported by substantial evidence. *Id.* In other words, we ask whether the record taken as a whole would support the verdict in the mind of a reasonable person. *Id.* It is not our duty, however, to reevaluate the weight or credibility of the evidence. *Comark Commc'ns, Inc. v. Harris Corp.*, 156 F.3d 1182, 1192 (Fed. Cir. 1998).

Evidentiary rulings by the district court are reviewed under regional circuit law. *Advanced Cardiovascular Sys., Inc. v. Medtronic, Inc.*, 265 F.3d 1294, 1308 (Fed. Cir. 2001). Thus, we review decisions to admit expert testimony for abuse of discretion under Seventh Circuit law. *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 152 (1999); *United States v. Allen*, 390 F.3d 944, 949 (7th Cir. 2004).

Inequitable conduct pertains to and arises under the patent laws; we therefore review it pursuant to Federal Circuit law. *In re Spalding Sports Worldwide, Inc.*, 203 F.3d 800, 803-04 (Fed. Cir. 2000). We review an inequitable conduct determination under an abuse of discretion standard and the underlying factual issues of materiality and intent for clear error. *Bristol-Myers Squibb Co. v. Rhone-Poulenc Rorer, Inc.*, 326 F.3d 1226, 1234 (Fed. Cir. 2003).

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B. *Infringement Evidence*

Vaughan's first alleged error is that LD presented insufficient evidence that each of the 47 accused installations infringed. First, it explains that LD did not present sufficient evidence that 11 of the 47 installations met the required nozzle placement and nozzle angle limitations required by claims 1 and 8. Second, Vaughan argues that LD's computer simulations presented at trial were inaccurate and therefore did not provide evidence of infringement. Third, Vaughan contends that there is no evidence Vaughan knew or intended that 11 of its systems, which are located outside the United States, indirectly infringe.

1. Tank Structure Limitations

The '414 patent requires that the tank nozzles be placed within 25 to 75 percent of the tank's annular radius and that the nozzle angle be sufficient to "generate flows . . . [that] impart a rotational movement of the entire body of liquid." '414 patent, col. 9, ll. 4-12. Vaughan explains that the structural data compiled by Gillette do not provide nozzle angles for 11 installations and do not provide radial distances and relative nozzle placements for 8 of those 11 installations. Further, it points out that Dorsch testified to his knowledge of four installations with nozzles located outside the annular regions claimed by the patent.

LD agrees that 11 of the tanks had some missing structural information; however, it submits Dorsch's testimony stating that even where there is missing information, one could generally reconstruct a tank using

the specification in the Vaughan engineering manual. Moreover, it contends that the Vaughan engineering manual shows nozzle placement within the claim limitations and that one drawing is almost an exact duplicate of the Augusta installation.

Our task on appeal is to determine whether the jury could reasonably have inferred from the engineering manual and Dorsch's testimony that 11 installations infringe even though some structural data is missing from Vaughan's records. LD argues this was a reasonable weighing of the evidence that is exclusively within the province of the jury. We agree.

A patentee may prove direct infringement or inducement of infringement by either direct or circumstantial evidence. *Moleculon Research Corp. v. CBS, Inc.*, 793 F.2d 1261, 1272 (Fed. Cir. 1986). There is no requirement that direct evidence be introduced, nor is a jury's preference for circumstantial evidence over direct evidence unreasonable *per se*. *See Fuji Photo Film Co. v. Jazz Photo Corp.*, 394 F.3d 1368, 1374 (Fed. Cir. 2005); *Moleculon Research*, 793 F.2d at 1272 (noting "it is hornbook law that direct evidence of a fact is not necessary"); *see also Michalic v. Cleveland Tankers, Inc.*, 364 U.S. 325, 330 (1960) ("Circumstantial evidence is not only sufficient, but may also be more certain, satisfying and persuasive than direct evidence."). Though Dorsch testified that four tanks were outside the scope of the patent claims, the jury could reasonably have discredited that evidence and given more weight to the circumstantial evidence of the Vaughan engineering manual, which was created before litigation began. Similarly, the jury could reasonably rely on the engineering manual and complete records for the

remaining Vaughan designs to infer that the missing information on 11 tanks also had infringing structural components.

Both parties argue that the other should have submitted additional evidence regarding the tank parameters. Though it is LD's burden to prove infringement, it chose to rely on circumstantial evidence for some installations. While direct evidence may have made LD's case of infringement stronger, it does not render the case presented to the jury unreasonable as a matter of law. Indeed, the jury could have reasonably inferred from the evidence submitted that each of the tanks infringed the claims. Thus, we hold that there is substantial evidence that all 47 accused tanks met the structural limitations of the '414 patent.

2. Computer Simulations

Next, Vaughan challenges the computer simulations used to establish the helical- and rotational-flow claim limitations. Vaughan maintains that Lueptow's simulations were insufficient for two reasons: (1) because the parameters used to run the nine different modeled simulations were inaccurate and (2) because the simulations do not show the required helical flow and general body rotation.

a. Lueptow's Model Parameters

First, Vaughan argues that the modeling parameters were inaccurate. It notes specifically that the simulated Tank A and Tank G groupings in Lueptow's CFDs did not match or approximate many of the known tank parameters such as the

height, flow rate, and nozzle diameter. Lueptow admitted that these parameters did not match the real-world parameters as Vaughan points out, but he also testified that the changes in the nozzle design would do little to disrupt the robust helical flow in the tanks. Furthermore, Lueptow performed a simulation of the Tank D parameters with different nozzle spacing and concluded that even though the parameters changed and some aspects of the flow changed, the helical flow was still present.

Vaughan appears to challenge the admissibility and reliability of Lueptow's expert scientific analysis and opinion. LD argues that our previous opinion reversing the district court's grant of summary judgment based on the genuine issue of material fact presented by the vector plots makes the evidence admissible under the law-of-the-case doctrine. Our previous opinion, *LD I,* did not directly consider the admissibility of the evidence, only that such evidence would be sufficient to create a genuine issue of material fact for trial. 355 F.3d at 1371. Issues not decided by the court in a prior proceeding are not covered by the law-of-the-case doctrine. *Stearns v. Beckman Instruments, Inc.,* 737 F.2d 1565, 1568 (Fed. Cir. 1984). Therefore, the admissibility of Lueptow's testimony had not been previously resolved.

Vaughan's challenges to expert testimony and scientific evidence are analyzed under the Supreme Court's *Daubert* factors. *See Daubert v. Merrell Dow Pharm., Inc.,* 509 U.S. 579, 589 (1993). When faced with expert scientific testimony, a district court must first determine "whether the expert is proposing to testify to (1) scientific knowledge that (2) will assist the trier of fact to understand or determine a fact at

issue." *Id.* at 592. This requires an assessment of the reasoning and methodology underlying the testimony to determine whether it is scientifically valid. *Id.* In *Daubert,* the Supreme Court set forth four factors for district courts to consider when evaluating the validity and relevance of scientific evidence pursuant to Rule 702 of the Federal Rules of Evidence. *Id.* at 592-93. These factors include (1) whether the methodology can and has been tested, (2) whether the methodology is subject to peer review, (3) the potential rate of error, and (4) the general acceptance of the methodology. *Id.* at 593-94. The court further noted that the focus of a court's inquiry into the relevance and reliability of scientific evidence "must be solely on principles and methodology, not on the conclusions that they generate." *Id.* at 595.

Here, Vaughan's argument focuses on the parameters Lueptow applied, not on the reliability of CFD analysis in general. Indeed, CFD analysis has been previously recognized in the scientific community and has been recognized as reliable by at least one circuit. *See Quiet Tech. DC-8, Inc. v. Hurel-Dubois UK Ltd.,* 326 F.3d 1333, 1343-44 (11th Cir. 2003). In *Quiet Tech.,* the appellant challenged the credibility of CFD analysis for modeling aerodynamic properties in a jet engine. *Id.* at 1344. The appellant argued that the expert used incorrect data or was missing data to run the CFD software and used the wrong equations to run his CFD analysis of the engine's aerodynamic properties. *Id.* Such a flawed analysis, it argued, made the testimony and evidence unreliable. *Id.* at 1344-45. The court held that such an attack goes more to the weight of the evidence than to its admissibility. "The identification of such flaws in generally reliable scientific evidence is precisely the role of cross-

examination." *Id.* at 1345; *see also In re TMI Litig.*, 193 F.3d 613, 692 (3d Cir. 1999) ("So long as the expert's testimony rests upon "good grounds," it should be tested by the adversary process—competing expert testimony and active cross-examination—rather than excluded from jurors[']scrutiny for fear that they will not grasp its complexities or satisfactory [sic] weigh its inadequacies.'" (quoting *Ruiz-Troche v. Pepsi Cola of Puerto Rico Bottling Co.*, 161 F.3d 77, 85 (1st Cir. 1998))); *Wilmington v. J.I. Case Co.*, 793 F.2d 909, 920 (8th Cir. 1986) ("Virtually all the inadequacies in the expert's testimony urged here by [the defendant] were brought out forcefully at trial. . . . These matters go to the weight of the expert's testimony rather than to its admissibility.").

Here, Vaughan's challenge goes to the weight of the evidence rather than the admissibility of Lueptow's testimony and analysis. Though he admitted that his models did not exactly match the various accused tanks, this fact was fully discussed on cross examination. As in *Quiet Tech.*, his models were not the perfect models of each individual tank, but they were based on reliable scientific methodology and subject to cross examination and the proffering of further scientific analysis by Vaughan. We conclude that a reasonable juror could consider Lueptow's testimony explaining the very robust, helical flow in the models and infer that the similar accused tanks will produce flow similar to the modeled flow. Therefore, we will not contravene the province of the jury by reweighing Lueptow's testimony.

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b. Alleged Flows

Vaughan's challenges do not end with allegations of inaccurate data. It also challenges the relevance of Lueptow's testimony regarding general rotation of the fluid in combination with the helical flow. Vaughan argues that Lueptow's analysis performed only 40 to 50 iterations, a time frame that it suggests is only a few seconds after pump startup and, therefore, was not enough time to rotate the entire body of fluid.

However, such arguments do not overcome Lueptow's testimony that there was helical flow and general body rotation in his simulation even after 50 iterations. Furthermore, Lueptow did not rely solely on his CFD plots, but also on those that were admittedly continued for longer periods of time by Vaughan and LD when they simulated the Merced and generic tanks at AEA Technologies. Any fault within Lueptow's opinion was properly covered during cross examination. But, sufficient evidence still existed for a reasonable juror to find infringement.

Vaughan's last contention with the CFD analysis counters LD's reliance on the vertical vector plots from the PX19 and PX20 reports by presenting an argument that they are unreliable. Basically, Vaughan argues that movement shown in the vector plots represents the single-plane movement of a particle flowing in two planes: vertical and horizontal. For purposes of determining helical flow, the vertical-plane vector plot is critical. Vaughan explains that the vertical plot shows particles with very little movement in the vertical plane, but much more substantial movement in the horizontal

plane. It contends that the vertical vector plot in the PX19 report is consistent with a rotational vortex, as in the prior art, rather than helical flow. Essentially, it maintains that even though the vertical vector plots look helical, the actual particles are moving like a whirlpool around a common center and that even in that configuration there will be flow upward and downward somewhere in the tank.

While Vaughan's interpretation could be correct, the evidence presented suggests that the vertical vector plot is subject to different interpretations. There was substantial evidence presented to the jury to suggest that this plot represents a helical pattern. The plot appears to show two vortices on either side of the tank center. While these vortices may be aided by the fluid intake sump in the tank center, it appears clear in this figure that the downward speeds increase towards the pumps. Furthermore, for both the PX19 and PX20 reports, their authors acknowledge that flow vortices do exist in the vertical plane. Upon consideration of the evidence, the jury may have had a different interpretation than that postulated by Vaughan. There is certainly substantial evidence to support this jury's findings.

3. Foreign Infringement

Vaughan makes one final argument with respect to infringement under 35 U.S.C. § 271(f) by six tanks located outside of the United States. It argues that under § 271(f) there was insufficient evidence that it intended for the foreign

purchasers to infringe the '414 patent. Pursuant to § 271(f)(1), a party may be an infringer if it

> supplies . . . in or from the United States all or a substantial portion of the components of a patented invention, where such components are uncombined in whole or in part, in such manner as to actively induce the combination of such components outside of the United States in a manner that would infringe the patent if such combination occurred within the United States . . .

"A finding of inducement requires both an underlying instance of direct infringement and a requisite showing of intent." *Fuji Photo Film Co.*, 394 F.3d at 1377. Here, although Vaughan contends that the requisite intent showing is missing, "[a] patentee may prove intent through circumstantial evidence." *Id.*

Accordingly, LD identifies evidence in the record that Vaughan knew of the '414 patent after its first sale to Augusta. Moreover, Vaughan's hiring of Behnke, a former LD employee with knowledge of the patented design, and Dorsch's statements indicating that Vaughan was relying on nozzle orientations from Behnke, support the proposition that Vaughan intended for its Augusta design to infringe the claims of the '414 patent. Furthermore, Vaughan's engineering manual was sent to its customers and is replete with examples that are similar to the Augusta designs. This constitutes circumstantial evidence that Vaughan intended for its subsequent buyers, including foreign buyers, to install systems that infringe the claims of the '414 patent. Vaughan

argues that the engineering manual itself expresses an intent to mix by rotation, such that Vaughan's dissemination of the manual did not *intend* its customers to create the infringing helical flow. Vaughan's arguments ask us to reweigh the evidence, a task reserved for the jury, not this court. *See Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1335 (Fed. Cir. 2002). Thus, we hold that there is substantial evidence to support the jury's verdict under § 271(f).

C. *Invalidity of the '414 Patent*

Vaughan's second allegation of error is that the court should have found the '414 patent invalid because the specification did not disclose the inventor's best mode of practicing the invention and did not enable the claims. *See BJ Servs. Co. v. Halliburton Energy Servs.*, 338 F.3d 1368, 1371-72 (Fed. Cir. 2003); *Eli Lilly & Co. v. Barr Labs.*, 251 F.3d 955, 963 (Fed. Cir. 2001). It argues that the inventors failed to disclose the need for reducers on the tank nozzles and that the specification failed to enable the creation of helical flow in the tank.

1. Best Mode

Vaughan argues that the use of reducers on the tank nozzles was the best mode of practicing the invention, that it was known to the inventors, and that they failed to disclose it in their patent application. Vaughan presented evidence that the inventors installed reducers on the Plymouth and Indiana Packers tanks in order to increase flow velocity and impart more momentum into the large tanks.

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Inventors are required by 35 U.S.C. § 112, ¶ 1 to disclose the best mode for practicing their claimed inventions. A finding of patent invalidity based on best mode "requires clear and convincing evidence that the inventor both knew of and concealed a better mode of carrying out the claimed invention than that set forth in the specification." *Teleflex,* 299 F.3d at 1330. This is a two-part factual test inquiring into (1) whether the inventor subjectively "considered a particular mode of practicing the invention to be superior to all other modes at the time of filing" the application and (2) whether the inventor adequately disclosed that superior mode. *Id.*; *accord Eli Lilly & Co.,* 251 F.3d at 963. The best mode requirement does not require the disclosure of "routine details" that would be apparent to one of ordinary skill in the art practicing the invention. *Teleflex,* 299 F.3d at 1331-32. "Known ways of performing a known operation cannot be deemed intentionally concealed absent evidence of intent to deliberately withhold that information." *High Concrete Structures, Inc. v. New Enter. Stone & Lime Co.,* 377 F.3d 1379, 1384 (Fed. Cir. 2004).

In light of all the evidence presented on this issue, a reasonable jury could conclude that Vaughan failed to demonstrate by clear and convincing evidence that LD did not disclose the best mode. First, the '414 patent states that "[t]he jet nozzle units 20 are preferably of a type disclosed in U.S. Pat. No. 4,332,484 (herein incorporated by reference) [("the '484 patent")] and commercially available from A.O. Smith, as part of its Slurrystore . . . systems." '414 patent, col. 4, ll. 52-55. The '484 patent describes a nozzle that discharges "a high velocity high volume jet," col. 3, ll. 50-51, and a nozzle which is "concentrically reduced in diameter

in its upward extend . . . ," col. 3, II. 65-68. Second, Crump testified that the Plymouth and Indiana Packers installations did not incorporate the invention and were used to achieve zone mixing instead of helical flow. Third, LD presented evidence that adding reducers is a routine detail and did not need to be disclosed to a person of ordinary skill in the art. Fourth, Lueptow testified that a particular flow velocity did not matter given that the fluid flow began to dissipate further from the nozzle.

Admittedly, the '414 patent does not disclose a particular size of reducer, but Vaughan failed to demonstrate by clear and convincing evidence that it must. Ideal flow rates and flow velocities depend on the nature of the tank to be mixed. Moreover, Vaughan has not made a sufficient showing to overcome the jury determination that the best mode requirement was satisfied.

2. Enablement

Vaughan argues that the '414 specification fails to enable the claimed helical flow. It contends that Crump's testimony that he did not discover helical flow until after his patent application was filed is proof that the specification does not enable the claim to such flow.[2]

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2. Vaughan also argues that the district court improperly excluded expert testimony regarding enablement. The district court excluded the expert opinion evidence as irrelevant because it was based on an impermissible claim construction and relied heavily on Figure 6 of the patent specification that shows perfect helical flow instead of substantial helical flow. Furthermore, the court found that

(Cont'd)

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In order to enable the claims of a patent pursuant to § 112, the patent specification must teach those of ordinary skill in the art "how to make and use the full scope of the claimed invention without undue experimentation." *Bruning v. Hirose,* 161 F.3d 681, 686 (Fed. Cir. 1998). Some experimentation is permissible although it cannot be unduly excessive. *Hybritech, Inc. v. Monoclonal Antibodies, Inc.,* 802 F.2d 1367, 1384 (Fed. Cir. 1986). Enablement is a question of law which we ultimately review de *novo,* but it is based on factual findings that are reviewed for clear error. *Bruning,* 161 F.3d at 686. Here, because the underlying inquiry was inherently factual, "we look to whether a reasonable jury could have made the underlying factual findings necessary to provide substantial evidence in support of its conclusion." *BJ Servs. Co.,* 338 F.3d at 1371-72.

First, LD submitted Gillette's testimony to establish that even though the patent does not discuss a specific combination of elements to create helical flow, it could be produced by a person of ordinary skill in the art without undue experimentation. Second, Crump's testimony indicates that he conceived of the idea of producing helical flow in late 1991 or early 1992, constructively reduced his idea to practice in the patent application, then confirmed that the helical flow could be produced in his later tank designs. This testimony, along with Lueptow's indication that helical flow is robust,

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(Cont'd)

the evidence could prejudice and confuse the jury. Since the enablement inquiry necessarily depends on an interpretation of the claims, we conclude that the district court did not abuse its discretion in excluding the expert's testimony pertaining to enablement.

provides substantial evidence that helical flow could be generated by following the '414 patent written description.

D. *Willful Infringement*

Vaughan also argues that there was not clear and convincing evidence to support the jury's verdict of willful infringement. Vaughan's only contentions are that there was no basis on which the jury could disregard Vaughan's reliance on counsel's opinion of non-infringement and that there was insufficient evidence that Vaughan copied the Augusta system.

A finding of willful infringement is made after considering the totality of the circumstances. *See Knorr-Bremse Systeme Fuer Nutzfahrzeuqe GmbH v. Dana Corp.*, 383 F.3d 1337, 1342-43 (Fed. Cir. 2004) (*en banc*). The evidence is weighed and evaluated by the trier of fact. *Id.* at 1343. "The drawing of inferences, particularly in respect of an intent-implicating question such as willfulness, is peculiarly within the province of the fact finder that observed the witnesses." *Rolls-Royce, Ltd. v. GTE Valeron Corp.*, 800 F.2d 1101, 1110 (Fed. Cir. 1986).

Courts consider several factors when determining whether an infringer has acted in bad faith and whether damages should be increased. They include: "(1) whether the infringer deliberately copied the ideas or design of another; (2) whether the infringer, when he knew of the other's patent protection, investigated the scope of the patent and formed a good-faith belief that it was invalid or that it was not infringed; . . . (3) the infringer's behavior as a party

to the litigation;" (4) "defendant's size and financial condition;" (5) "closeness of the case;" (6) "duration of defendant's misconduct;" (7) "remedial action by the defendant;" (8) "defendant's motivation for harm;" and (9) "whether defendant attempted to conceal its misconduct." *Read Corp. v. Portec, Inc.*, 970 F.2d 816, 826-27 (Fed. Cir. 1992) (superseded on other grounds as recognized in *Hoechst Celanese Corp. v. BP Chems. Ltd.*, 78 F.3d 1575, 1578 (Fed. Cir. 1996)). Good faith may normally be shown by obtaining the advice of legal counsel as to infringement or patent validity. *See id.* at 828. If counsel's opinion is found to be incompetent, however, a fact finder may discount its usefulness in determining a party's good faith. *See id.* at 828-29; *see also Goodwall Constr. Co. v. Beers Constr. Co.*, 991 F.2d 751, 758 (Fed. Cir. 1993) (holding that a jury could have concluded that the infringing party concealed incriminating evidence from its opinion counsel).

Here, LD cites to several pieces of evidence the jury may have relied on to find copying. One of the most persuasive pieces of evidence appears to be Vaughan's competing bid on the Augusta tank. Though the engineering drawings are virtually duplicates of LD's job proposal, that is not the most persuasive evidence that the jury may have relied upon to infer copying. LD presented evidence that Vaughan used Behnke, a former LD employee with intimate knowledge of the Augusta tank and LD's Jetmix system, to establish a nozzle angle of its own Rotamix system. While Vaughan discounts this evidence because it used a different nozzle height and a dual-nozzle design instead of the single-nozzle design LD proposed to Augusta, the jury could reasonably infer that Vaughan was deliberately trying to create the same

flow pattern as LD's Jetmix system in violation of the '414 patent. There is no limitation in the '414 patent requiring single-nozzle systems. In fact, the '414 patent contemplates the use of "various flow devices of a system [that] may be installed at differing heights, if desired . . . and may be combined in pairs." Col. 8, II. 35-44. Thus, Vaughan's argument that the jury could not find copying because its Augusta proposal made insubstantial changes to a patented invention does not overcome the substantial evidence to the contrary. Furthermore, the Vaughan engineering manual includes a drawing similar in detail to the Augusta tank layout, a fact the jurors could have used to infer copying.

Though Vaughan relies heavily on its opinion of counsel, LD presented flaws in that opinion's factual basis. LD explains that patent counsel was not given the complete CFD analysis because he was not provided with the vertical vector plots of fluid flow. Patent counsel was advised that the vertical plots did not show anything of significance. In fact, the report on the Merced and generic 50-foot tanks explained that the vertical plots indicated vertical flow and secondary flow vortices. The jury could use such a concealment of evidence from the attorney to discount the opinion. *See Goodwall Constr.*, 991 F.2d at 758. Although Vaughan asserts that the district court's enhancement of damages should be reversed, the primary basis for this position is that the jury's finding of willfulness should be reversed, an argument we have already rejected. Vaughan's only other argument is that litigation misconduct did not justify enhancement but that argument was made only in a footnote in the opening brief and therefore was not sufficiently preserved. *SmithKline Beecham Corp. v. Apotex Corp.*, 439 F.3d 1312, 1320 (Fed. Cir. 2006).

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E. *Inequitable Conduct*

Finally, Vaughan argues that the district court improperly granted LD's JMOL for its inequitable conduct claim. Vaughan maintains that the court committed clear error by finding that the Plymouth and Indiana Packers installations were not prior art that should have been disclosed to the patent examiner.

Patent applicants are required to prosecute patents "with candor, good faith, and honesty." *See Bristol-Myers Squibb Co.*, 326 F.3d at 1233 (citation omitted). "A breach of this duty can take several forms: 'affirmative misrepresentation of a material fact, failure to disclose material information, or submission of false material information.' Further, a breach of this duty, when coupled with an intent to deceive or mislead the PTO, constitutes inequitable conduct, which, when proven, renders the patent unenforceable." *Id.* (citations omitted). In order to establish inequitable conduct, Vaughan must present clear and convincing evidence that the inventors "failed to disclose material information with an intent to mislead the PTO." *Id.* at 1233-34.

The district court found that Crump's testimony regarding the process of invention was credible and believed that the Plymouth and Indiana Packers installations were not material information because they were "very different configurations" from the claimed invention and were part of an "evolving process of experimentation by the inventors." The court also found that even if the previous installations had been material, Crump's testimony that he did not intend to deceive the patent office was credible and his extensive

prior art disclosures during prosecution strongly suggested good faith.

Our inquiry into materiality is an objective one. "Materiality is not limited to prior art but embraces any information that a reasonable examiner would be substantially likely to consider important in deciding whether to allow an application to issue as a patent." *Bristol-Myers Squibb Co.*, 326 F.3d at 1234 (citation omitted). Here, the district court erred in its analysis of materiality. The court focused on whether the prior installations actually embody the invention, when the correct analysis asks whether a reasonable examiner would find it important. In this case, the inventors explain how they developed the invention and their use of the Plymouth and Indiana Packers tanks to do so. They certainly used the previous tanks to assist in developing the invention and the tanks were part of a sale, not an experiment. A reasonable patent examiner would find such information important to his consideration of the patent application.

However, Vaughan fails to establish that the inventors had the requisite intent to deceive. Intent is a subjective inquiry into whether the inventor knew the information was material and chose not to disclose it. *See id.* at 1239. Here, Vaughan asks us to reweigh the credibility of the evidence and testimony, something we cannot do. *See LNP Eng'g Plastics, Inc. v. Miller Waste Mills, Inc.*, 275 F.3d 1347, 1361 (Fed. Cir. 2001). The trial court relied on the evidence that Crump did not believe the prior installations were necessary disclosures because they were not embodiments of the invention and were similar to other disclosures. Furthermore,

Crump testified that he did inform the examiner of the prior tanks. We see no reversible error in the district court's analysis of intent. Thus, the court's finding of no inequitable conduct was not clearly erroneous.

III. CONCLUSION

In this appeal, Vaughan asks us to review the district court's denial of their JMOL motion for non-infringement, invalidity, no willful infringement, and unenforceability due to inequitable conduct. For the reasons stated in this opinion, we find no reversible error. Accordingly, we affirm.

AFFIRMED

APPENDIX B — MEMORANDUM OPINION AND ORDER OF THE UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF ILLINOIS, EASTERN DIVISION DATED MAY 12, 2005

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

No. 01 C 6934

Suzanne B. Conlon, Judge

LIQUID DYNAMICS CORPORATION,

Plaintiff,

v.

VAUGHAN COMPANY, INC.,

Defendant.

MEMORANDUM OPINION & ORDER

Liquid Dynamics Corporation ("Liquid Dynamics") sued Vaughan Company, Inc. ("Vaughan") for infringement of U.S. Patent No. 5,458,414 ("the '414 patent") pursuant to 35 U.S.C. § 271 *et seq.* On October 25, 2004, Liquid Dynamics received a $1,183,722.00 jury verdict in its favor on willful infringement and invalidity claims, and on November 12, 2004, the court granted Liquid Dynamics' motion for judgment as a matter of law on Vaughan's inequitable conduct counterclaim. Liquid Dynamics was

awarded prejudgment and post-judgment interest and injunctive relief on February 22, 2005; Liquid Dynamics was also awarded $52,148.22 in costs. Dkt. No. 263. On March 22, 2005, Liquid Dynamics was awarded enhanced damages pursuant to 35 U.S.C. § 284 in the amount of $2,367,444. *Liquid Dynamics Corp. v. Vaughan Co., Inc.*, No. 01 C 6934, 2005 U.S. Dist. LEXIS 6162, *4-7 (N.D. Ill. Mar. 22, 2005). Liquid Dynamics now seeks $1,615,455 in attorney's fees, $69,427 in expert fees and $143,120 in costs pursuant to 35 U.S.C. § 285 and 28 U.S.C. § 1927.

DISCUSSION

I. Timeliness

Vaughan contends Liquid Dynamics' motion for attorney's fees is untimely under Local Rule 54, which requires the motion be filed no later than 90 days after judgment. Judgment was entered on the inequitable conduct counterclaim on November 15, 2004. Liquid Dynamics filed its original attorney's fees motion on February 10, 2005 – within the 90 day limit. The motion for fees was complete, but Liquid Dynamics requested leave to supplement the motion to include fees incurred in bringing the motion. Because the filing, on its face, indicated Liquid Dynamics sought leave to file additional materials, the court struck the motion without prejudice on February 15th. Liquid Dynamics filed a renewed motion for attorney's fees – and withdrew its request to supplement with additional fees – the next day. While the renewed motion was filed after the 90 day deadline, the original timely filing and the renewed filing request an identical amount in fees and costs. Vaughan has therefore

not been prejudiced. Vaughan received timely service of the motion. Because the original motion included the parties' Local Rule 54.3 joint statement, Vaughan was on notice of the bases for Liquid Dynamics' motion in January 2005. Accordingly, the motion is timely.[1]

II. Attorney's Fees

A. Exceptional Case

"The court in exceptional cases may award reasonable attorney fees to the prevailing party." 35 U.S.C. § 285. The requirements for awarding attorney's fees under § 285 are: "(1) the case must be exceptional; (2) the district court may exercise its discretion; (3) the fees must be reasonable; and (4) the fees may be awarded only to the prevailing party." *Machinery Corp. of America v. Gullfiber AB*, 774 F.2d 467, 470 (Fed. Cir. 1985). Liquid Dynamics is clearly the prevailing party. Accordingly, the court must determine whether the case is exceptional, whether to exercise discretion in awarding fees, and whether the requested fees are reasonable.

As the prevailing party, Liquid Dynamics bears the burden of proving the exceptional nature of the case by clear and convincing evidence. *See e.g., Beckman Instruments, Inc.*

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1. Vaughan reminds the court that its attorney's fees motion was struck as untimely after it succeeded on summary judgment. *See* Dkt. No. 111-1. However, Vaughan completely failed to file its motion within the 90-day limit and failed to provide Liquid Dynamics with documentation of fees as required by Local Rule 54.3(d)(4).

v. LKB Produkter AB, 892 F.2d 1547, 1551 (Fed. Cir. 1989). A willful infringement finding is sufficient to support an attorney's fee award. The court must explain the failure to award attorney's fees in the face of a willfulness determination. *See e.g., Applied Med. Res. Corp. v. United States Surgical Corp.*, 967 F. Supp. 861 (E.D. Va. 1997), *citing Avia Group Int'l v. L.A. Gear California, Inc.*, 853 F.2d 1557, 1566 (Fed. Cir. 1988). However, neither a willfulness determination nor an enhanced damages award compel attorney's fees. *See id.* The attorney's fee award remains a matter of discretion. *Id.*

Liquid Dynamics contends this case is exceptional because of the willful infringement verdict, Vaughan's intentional copying of the '414 patent and because Vaughan had no good faith belief of non-infringement. Vaughan's contentions regarding the absence of evidence of copying and its reasonable belief of non-infringement must be rejected. The court addressed and rejected those arguments in its enhanced damages ruling and determined: (1) the evidence supports a finding that Vaughan deliberately copied Liquid Dynamics' patented design; and (2) the jury's rejection of Vaughan's good faith defense was supported by sufficient evidence. *See Liquid Dynamics Corp. v. Vaughan Co., Inc.*, No. 01 C 6934, 2005 U.S. Dist. LEXIS 6162, *4-7 (N.D. Ill. Mar. 22, 2005). In light of the willfulness verdict, the evidence of intentional copying and the lack of evidence to support a good faith defense, the exceptional nature of the case has been established by clear and convincing evidence.

Liquid Dynamics further contends the court should exercise its discretion to award fees because Vaughan

engaged in litigation misconduct. To the extent Liquid Dynamics points to a Vaughan witness' deposition testimony, the insufficiency of Vaughan's discovery production, Vaughan's post-trial motions and Vaughan's examination of witnesses at trial, the arguments are disregarded. Nevertheless, the court agrees Vaughan's behavior as a litigant was inappropriate. Vaughan's misconduct is detailed in the ruling that enhanced damages are justified. *See Liquid Dynamics*, 2005 U.S. Dist. LEXIS 6162 at *7-11. Vaughan's pattern of irresponsible litigation behavior proliferated the litigation, caused unreasonable expense and wasted judicial resources.[2] Accordingly, the court exercises its discretion to award attorney's fees.

B. Reasonableness of Fees

"The most useful starting point for determining the amount of a reasonable fee is the number of hours reasonably expended on the litigation multiplied by a reasonable hourly rate." *Hensley v. Eckerhart*, 461 U.S. 424, 433, 103 *S.* Ct. 1933 (1983). After the initial calculation, "there remain other considerations that may lead the district court to adjust the fee upward or downward." *Id.* at 434. Other considerations may include proper documentation of hours worked, overstaffing, redundant work, excessive hours, and the ultimate result of the litigation." *Id.* at 433-34.

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2. Vaughan contends Liquid Dynamics also engaged in litigation misconduct and, if the court awards fees based on misconduct, the amount should be reduced to $50,000, "the maximum amount of attorney's fees Liquid Dynamics may have incurred in response to the alleged misdeeds." Resp. at 17. Vaughan provides no support for its $50,000 figure and its petty allegations of misconduct are not comparable to its own conduct.

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Liquid Dynamics calculates its attorney's fees as:

Attorney/Biller	Avg. Rate	Hours	Total
Steven C. Schroer	$467.68	388.60	$181,739.00
Mark W. Hetzler	$336.85	2090.07	$704,048.70
Jon A. Birmingham	$207.93	1957.25	$406,973.75
Other Partners	$322.44	268.35	$86,526.25
Other Associates and Law Clerks	$130.59	716.58	$93,578.60
Paralegals and Other Support	$101.95	1398.57	$142,589.00
Total:			**$1,615,455.30**

Vaughan argues the requested $1,615,455.30 must be reduced by $691,799.80: (1) $236,167.60 for fees charged by non-lawyers; (2) $253,632.20 for inadequate billing descriptions; and (3) $202,000 for excessive staffing of litigators.

1. Reasonableness of Hourly Rates

Liquid Dynamics bears the burden of proving that "the requested rates are in line with those prevailing in the community for similar services of lawyers of reasonably comparable skill and reputation." *View Eng., Inc. v. Robotic*

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Vision Sys., Inc., 208 F.3d 981, 987 (Fed. Cir. 2000) (citations omitted). Accordingly, Liquid Dynamics compares its attorneys' average rates with the surveyed rates for Chicago intellectual property attorneys reflected in the American Intellectual Property Association ("AIPLA") 2003 survey. The AIPLA survey has been used by other courts in determining the reasonableness of hourly rates. *See e.g., View*, 208 F.3d at 987; *Mathis v. Spears*, 857 F.2d 749, 755-56 (Fed. Cir. 1988); *Howes v. Medical Components, Inc.*, 761 F. Supp. 1193, 1196-97 (E.D. Pa. 1990). Liquid Dynamics' three principal attorneys were Steven C. Schroer, Mark W. Hetzler and Jon A. Birmingham. All attorneys practice at the Fitch, Even, Tabin & Flannery law firm. Schroer and Hetzler are firm partners. A comparison of the attorneys' average rates with the AIPLA study reflects:

Vaughan does not seriously contest the reasonableness of the attorneys' rates. Indeed, Hetzler's average rate of $336.85 is comparable to Vaughan attorney Robert Carlson's $359.29 rate. Birmingham's $207.93 average rate is comparable to Vaughan attorney Mark Walters' $230.16 rate. Schroer's average rate is higher than the Vaughan's attorneys' rates, and slightly higher than the AIPLA 75th percentile range, but it is not unreasonable. The AIPLA survey was based on results through May 26, 2003. It is reasonable to infer that litigation fees have increased since the survey's completion. Liquid Dynamics' hourly rates are reasonable.

2. Number of Litigators and Charges by Non-Lawyers

Vaughan complains Liquid Dynamics excessively used an army of litigators, secretaries, paralegals and law clerks in the litigation, resulting in an outrageous fee request that is $600,000 more than the jury's damages award. Preliminarily, the fact that the fee request exceeds the jury's verdict is not atypical in a patent case, and Vaughan provides no support to suggest otherwise. Nor does Vaughan support its argument that Liquid Dynamics inappropriately staffed the case. "Beyond the principle of reasonableness, parties need not justify their billing practices nor their use of time and resources in litigation." *Vardon Golf Co., Inc. v. Karsten Mfg. Corp.* , No. 99 C 2785, 2003 U.S. Dist. LEXIS 5072, at *14 (N.D. Ill. Mar. 31, 2003). Many individuals worked on Liquid Dynamics' behalf. However, the billing records reflect Schroer, Hetzler and Birmingham handled the majority of the work. Vaughan does not dispute that each party's litigation team consisted primarily of two partners, one associate and

three paralegals. Vaughan contends Liquid Dynamics' expenditures exceeded Vaughan's by more than 36%. However, Vaughan fails to show that the difference in expenditures is unreasonable. *See id.* at *7 (prevailing party received almost all of its requested 8966.65 hours even where non-prevailing party spent 3153.82 hours). Accordingly, Vaughan's objections to Liquid Dynamics' staffing of the case are rejected.

Vaughan also objects to Liquid Dynamics' request for fees charged by non-lawyers. Attorney's fees under § 285 include expenditures the prevailing party incurs in preparation for and performance of legal services related to the suit. *See e.g., Central Soya Co., Inc. v. Geo. A. Hormel & Co.*, 723 F.2d 1573, 1578 (Fed. Cir. 1983). Fees under § 285 may include time charged by non-legal personnel and paralegal personnel. *See id., citing Codex Corp. v. Milgo Electronic Corp.*, 541 F. Supp. 1198, 1201 (D. Mass. 1982). However, secretarial tasks are generally considered overhead costs that are unrecoverable as attorney's fees. *See e.g., Roe v. Chicago,* 586 F. Supp. 513, 516 (N.D. Ill. 1984); *see also, Burnley v. City of San Antonio,* No. SA-02-CA-0489 NN, 2004 U.S. Dist. LEXIS 21565, *11-13 (W.D. Tex. Sept. 15, 2004). Liquid Dynamics seeks $5197.50 for secretarial overtime; its billing invoices reflect charges for secretarial "document supervision." These fees are inappropriate. The fees request is reduced by $5197.50.

3. Adequacy of Billing Descriptions

Liquid Dynamics attaches copies of billing invoices to support its motion. Mot. at Ex. 29. Vaughan contends many

of the invoice entries lack sufficient description to enable a determination as to whether the expenditure was reasonably incurred. Vaughan also contends Liquid Dynamics has not submitted copies of checks demonstrating that all billed fees were actually paid. "Although the amount the client paid the attorney is one factor for the court to consider in determining a reasonable fee, it does not establish an absolute ceiling." *Junker v. Eddings,* 396 F.3d 1359, 1365 (Fed. Cir. 2005). The submission of checks that Liquid Dynamics paid to its attorneys is not essential.

However, Liquid Dynamics heavily redacted its billing invoices. As a result, many descriptions prevent the court from evaluating the reasonableness of some purported costs. *See e.g., Hensley v. Eckerhart,* 461 U.S. 424, 433, 103 S. Ct. 1933 (1983) (where documentation is inadequate district court may reduce the award); *Vardon,* 2003 U.S. Dist. LEXIS 5072, at *17 (not awarding fees for vaguely described "pretrial preparation and strategy.") "[A]ttomeys are required to submit reasonably specific information to support the award of attorney's fees"); *see also Junker,* 396 F.3d at 1366 (evidence required to determine a reasonable attorney fee includes detailed billing records). Indeed, some requested fees do not even have a description. Further, some entries appear unreasonably duplicative. The following challenged entries fail to meet "a fee applicant's heavy obligation to present well-documented claims,"see *Role Models America, Inc. v. Brownlee,* 353 F.3d 962, 971 (D.C. Cir. 2004), and are not awarded:

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Attorney	Experience	Rate Range (2001-2004)	Average Rate	AIPLA Survey (median)	AIPLA Survey (75th percentile)
Schroer	30-34 years	$415-475	$467.68	$370	$450
Hetzler	10-14 years	$300-360	$336.85	$300	$350
Birmingham	<5 years	$185-235	$207.93	$196	$230

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Date	Attorney	Hours	Cost	Description
8/17/01	TPM	2.25	$ 675.00	Reviewed _____ and conference with attorney Hetzler regarding litigation
9/25/01	MWH	2.50	$ 750.00	Review legal research _____
9/28/01	MWH	4.00	$1200.00	Review legal research _____
9/25/01	SCS	.50	$ 207.50	Confs _____
9/28/01	SCS	.50	$ 207.50	T/confs _____
10/10/01	TPM	.30	$ 90.00	Reviewed Vaughan _____
10/25/01	SCS	.25	$ 103.75	Telephone conference _____

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Date	Attorney	Hours	Cost	Description
1/21/02	MWH	5.00	$1500.00	Prepare _____ outline
1/30/02	MWH	7.50	$2250.00	Preparation ____ letter to opposing counsel re outstanding discovery issues
1/30/02	JB	5.50	$1017.50	Discuss case with MWH; prepare _____; prepare _____; prepare _____; telephone conference with Mark Crump
1/31/02	MWH	7.50	$2250.00	Preparation _____; conference with J. Birmingham and potential expert

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Date	Attorney	Hours	Cost	Description
2/12/02	NTP	1.00	$110.00	Research _____
2/14/02	TPM	.30	$ 90.00	Attention to discovery issues
2/16/02	JB	5.00	$925.00	Prepare _____
2/18/02	NV	2.67	$200.25	Assemble materials _____
2/20/02	NTP	6.00	$660.00	Research _____
3/06/02	NTP	3.50	$385.00	Prepare _____
3/09/02	JB	3.00	$600.00	Prepare _____; prepare_____; discuss matter with MWH; prepare _____

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Date	Attorney	Hours	Cost	Description
3/11/02	JB	6.00	$1200.00	Prepare _____; prepare _____; telephone conference with Lueptow; discuss matter with MWH
3/13/02	MJR	3.75	$ 375.00	Attend _____ documentsVaughan produced
4/03/02	MJR	3.00	$ 300.00	Research _____
4/03/02	NTP	1.75	$ 192.50	Research _____
4/04/02	JB	5.50	$1100.00	Prepare motion.

Date	Attorney	Hours	Cost	Description
4/10/02	MJR	3.50	$ 350.00	Research _____
4/10/02	NTP	.50	$ 55.00	Meet and begin research _____
5/03/02	JM	3.00	$ 300.00	Working on several small projects forJAB
5/15/02	KP	5.00	$ 600.00	Research _____
5/19/02	JB	5.75	$1150.00	Prepare _____
5/20/02	KP	6.00	$ 720.00	Research _____
5/21/02	JM	3.00	$ 300.00	Attend to several projects for JAB
5/21/02	KP	3.00	$ 360.00	Research _____

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Date	Attorney	Hours	Cost	Description
5/22/02	JM	2.00	$200.00	Attend to several projects for JAB
5/29/02	JAC	2.00	$240.00	Legal research _____
5/30/02	JAC	1.00	$120.00	Continued legal research
5/31/02	JM	1.00	$100.00	Various projects, refile folders _____
5/29/02	SG	4.00	$400.00	Case research _____
5/30/02	SG	3.50	$420.00	Case research _____
6/05/02	KP	.50	$ 60.00	Research _____
6/05/02	JAC	.75	$ 90.00	Legal research _____
6/06/02	KP	4.50	$540.00	Research _____

Date	Attorney	Hours	Cost	Description
6/06/02	JAC	2.75	$330.00	Continue research _____
6/06/02	JAC	.50	$ 60.00	Legal research _____
6/07/02	KP	4.00	$480.00	Research _____
6/10/02	SG	5.00	$600.00	Research case law _____
6/10/02	JAC	3.00	$360.00	Legal research _____
6/12/02	KP	3.00	$360.00	Research _____
6/13/02	SG	2.00	$240.00	Research _____
6/14/02	JJH	.25	$100.00	Review of materials _____
6/14/02	BJL	2.50	$250.00	Research _____

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Date	Attorney	Hours	Cost	Description
6/19/02	SG	.75	$ 90.00	Research _____
6/19/02	JAC	1.50	$180.00	Legal research _____
6/19/02	JAC	.75	$ 90.00	Legal research _____
6/26/02	SG	1.00	$120.00	Legal research _____
6/26/02	SG	4.50	$340.00	Legal research _____
6/27/02	SG	1.00	$120.00	Legal research _____
7/08/02	SG	6.00	$720.00	Research _____
7/09/02	SG	3.00	$360.00	Legal Research _____
7/29/02	JB	2.25	$450.00	_____

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Date	Attorney	Hours	Cost	Description
9/11/02	MWH	.75	$ 247.50	_____ revise notice
9/28/02	MWH	.50	$ 165.00	Attend to review of _____ telephone counsel re client
10/01/02	MWH	.75	$ 247.50	Review _____ prepare letter forwarding same to client
11/19/02	DLP	5.00	$ 800.00	Research _____
11/20/02	DLP	4.50	$ 720.00	_____ discuss matter with MWH
11/22/02	DLP	4.40	$ 704.00	Research regarding _____
1/20/03	DLP	6.40	$1024.00	Research _____

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Date	Attorney	Hours	Cost	Description
1/21/03	DLP	8.80	$1408.00	Research _____discussed results of research with Mr. Birmingham
1/25/03	JB	.75	$ 150.00	Legal research regarding _____
4/02/03	DLP	2.00	$ 320.00	Research _____
4/03/03	DLP	2.90	$ 464.00	Research _____ preparation of memo _____ research
4/04/03	DLP	1.30	$ 208.00	Research _____ preparation of memo _____
4/07/03	DLP	.50	$ 80.00	Research _____

Date	Attorney	Hours	Cost	Description
4/11/03	DLP	.90	$144.00	Research _____
4/14/03	DLP	1.00	$160.00	Research _____
4/15/03	DLP	1.10	$176.00	Research _____
4/24/03	JB	.50	$100.00	Legal research _____
1/26/04	MWH	.25	$ 90.00	_____
1/30/04	JB	.50	$117.50	Review _____
1/31/04	JB	.25	$ 58.75	Review _____
2/18/04	JAC	2.10	$325.50	Legal research _____
2/19/04	JAC	1.90	$294.50	Legal research _____

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Date	Attorney	Hours	Cost	Description
2/23/04	JAC	1.70	$ 263.50	Legal research _____
3/14/04	MWH	.17	$ 61.20	_____
6/23/04	MWH	.25	$ 90.00	_____
6/30/04	MWH	.50	$ 180.00	Telephone conference _____
6/30/04	JRB	4.75	$ 570.00	_____
7/09/04	JRB	.35	$ 42.00	Update _____
7/23/04	TPM	1.00	$ 380.00	Conference _____
7/25/04	MWH	5.00	$1800.00	_____
7/27/04	TPM	.75	$ 285.00	_____

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Date	Attorney	Hours	Cost	Description
8/04/04	MRR	5.00	$ 500.00	Research _____
8/10/04	RIK	8.00	$2320.00	Legal research _____
8/16/04	KSD	5.00	$ 500.00	Research _____
8/17/04	KSD	7.00	$ 700.00	Research _____
8/18/04	MRB	5.20	$1014.00	Legal research _____
8/18/04	RIK	5.00	$1450.00	Legal research _____ materiality; legal research _____
8/18/04	KSD	7.00	$ 700.00	Research _____ research _____ research _____
8/19/04	MRB	2.50	$ 487.50	Legal research _____

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Date	Attorney	Hours	Cost	Description
8/19/04	RIK	8.00	$2320.00	Legal research _____ legal research
8/20/04	RIK	7.00	$2030.00	Legal research ____ legal research _____
8/24/04	KSD	3.00	$ 300.00	Further research _____
8/25/04	KSD	4.25	$ 425.00	Research _____
8/26/04	KSD	4.25	$ 425.00	Reviewed _____
9/07/04	NA	4.00	$ 480.00	Research _____
9/08/04	KP	5.00	$ 775.00	Research _____ methods
9/08/04	CA	1.50	$ 202.50	Research case law _____
9/08/04	NA	7.75	$ 930.00	Research _____

Date	Attorney	Hours	Cost	Description
9/09/04	NTP	8.50	$1317.50	_____
9/09/04	KP	4.00	$ 620.00	Research _____
9/09/04	CA	3.75	$ 506.25	Reviewed _____ legal research
9/09/04	NA	3.75	$ 450.00	Research _____
9/10/04	KP	.80	$ 124.00	_____
9/10/04	CA	4.75	$ 641.25	Legal research _____
9/13/04	CA	1.50	$ 202.50	Research _____
9/13/04	NA	6.50	$ 780.00	Research _____
9/14/04	NA	2.25	$ 270.00	Research _____ write memo

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Date	Attorney	Hours	Cost	Description
9/15/04	NA	4.50	$540.00	_____ write memo
9/16/04	CA	6.00	$810.00	Research _____
9/16/04	NA	1.50	$180.00	Research _____
9/17/04	NA	2.03	$274.05	Research _____
9/20/04	CA	1.27	$171.45	Drafted _____
9/21/04	MWH	1.00	$360.00	Review _____
9/21/04	CA	1.39	$187.65	Drafted _____
9/21/04	NA	1.00	$120.00	Research _____
9/22/04	NA	5.75	$690.00	Research _____
9/23/04	CA	.51	$ 68.85	Researched _____

Date	Attorney	Hours	Cost	Description
9/23/04	NA	7.75	$ 930.00	Research issue _____
9/27/04	NA	8.00	$ 960.00	Write memo _____
7/07/04	SCS	1.75	$ 831.25	Confs _____
7/16/04	SCS	1.00	$ 475.00	Confs _____
8/02/04	SCS	1.00	$ 475.00	Attn to issues _____
10/05/04	RIK	3.00	$ 870.00	Legal research _____
10/07/04	CA	.10	$ 13.50	Met _____
10/07/04	NA	6.00	$ 720.00	Research _____
10/08/04	JB	5.00	$1175.00	_____
10/11/04	NA	1.75	$ 210.00	Research issue _____

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Date	Attorney	Hours	Cost	Description
10/12/04	KP	2.50	$387.50	_____
10/12/04	JAC	2.00	$310.00	Legal research _____
10/12/04	NA	6.25	$750.00	Research issue _____
10/13/04	KP	1.50	$232.50	_____
10/13/04	JAC	3.30	$511.50	Legal research _____
10/13/04	NA	5.50	$660.00	Research issue _____
10/14/04	NA	.25	$ 30.00	Research issue _____
10/14/04	NA	1.25	$150.00	Research _____
10/15/04	KP	3.50	$542.50	_____
10/15/04	JAC	.25	$ 38.75	_____

Date	Attorney	Hours	Cost	Description
10/15/04	NA	7.50	$ 900.00	Research _____
10/15/04	TMR	.25	$ 35.00	Proof read _____
10/20/04	JJH	3.50	$1470.00	Study _____
10/21/04	JJH	1.00	$ 420.00	Review _____
10/21/04	JJH	2.00	$ 840.00	_____
10/21/04	JJH	2.00	$ 840.00	_____
10/22/04	JJH	2.00	$ 840.00	_____
10/25/04	CA	.50	$ 75.00	_____
10/26/04	MWH	.75	$ 270.00	Legal research; _____
10/26/04	BL	1.50	$ 195.00	General reorganization

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Date	Attorney	Hours	Cost	Description
10/26/04	JB	1.25	$293.75	Legal research _____
10/27/04	JB	2.25	$528.75	Review legal research _____
10/29/04	JB	1.50	$352.50	Legal research _____
10/29/04	KP	4.20	$651.00	Legal research _____
10/29/04	NA	3.00	$360.00	Research Federal Circuit cases _____
10/30/04	RIK	2.00	$580.00	Legal research _____
10/31/04	DEB	4.50	$922.50	Conducting and analyzing legal research
11/01/04	RIK	1.00	$290.00	Legal research _____

Date	Attorney	Hours	Cost	Description
11/01/04	DEB	4.50	$ 922.50	Conducting and analyzing legal research
11/01/04	NA	5.25	$ 630.00	Research _____
11/02/04	DEB	8.50	$1742.50	Conducting and analyzing legal research
11/02/04	NA	6.25	$ 750.00	Research _____
11/03/04	NA	8.00	$ 960.00	Research _____
11/04/04	DEB	8.50	$1742.50	Conducting and analyzing legal research
11/04/04	NA	8.00	$ 960.00	Continue researching _____

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Date	Attorney	Hours	Cost	Description
11/05/04	NA	5.00	$ 600.00	Continue researching _____
11/07/04	RIK	3.00	$ 870.00	Legal research _____
11/07/04	DEB	5.50	$1127.50	Conducting and analyzing legal research
11/08/04	DEB	7.50	$1537.50	Conducting and analyzing legal research
11/08/04	NA	4.75	$ 570.00	Assemble _____
11/09/04	RIK	4.00	$1160.00	Legal research _____
11/09/04	DEB	9.50	$1947.50	Conducting and analyzing legal research
11/09/04	NA	8.00	$ 960.00	_____

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Date	Attorney	Hours	Cost	Description
11/10/04	JFF	1.00	$ 475.00	Conference and legal research
11/10/04	NA	2.00	$ 240.00	_____
11/12/04	RIK	3.00	$ 870.00	Legal research _____
11/15/04	JB	6.25	$1468.75	Prepare and review documents
11/15/04	NA	4.50	$ 540.00	_____
11/01/04	KP	4.80	$ 744.00	Legal research _____
11/02/04	KP	3.80	$ 589.00	Legal research _____
11/03/04	KP	3.20	$ 496.00	Legal research _____

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Date	Attorney	Hours	Cost	Description
11/04/04	KP	3.30	$ 511.50	Legal research _____
11/18/04	JFF	.50	$ 237.50	Legal research _____
11/29/04	NA	6.25	$ 750.00	Review cases _____
11/30/04	NA	1.25	$ 150.00	Research _____
Total:			**$109,017.70**	

4. Total Attorney's Fees Awarded

Liquid Dynamics requests $1,615,455 in attorney's fees. The court reduces the requested amount by $5197.50 for fees charged for secretarial staff and by $109,017.70 for inadequate billing descriptions. Accordingly, Liquid Dynamics is awarded $1,501,239.80 in attorney's fees.

III. Non-Taxable Costs

Section 285 is not limited to attorney's fees, but also includes expenses or costs not taxable under 28 U.S.C. § 1920. *See Central Soya Co. v. Geo. A. Hormel & Co.*, 723 F.2d 1573, 1578 (Fed. Cir. 1983) (Section 285 "include[s] those sums that the prevailing party incurs in the preparation for and performance of legal services related to the suit"). Liquid Dynamics seeks $69,427 in expert fees and $143,120 in costs.

A. Expert Fees

The court may not rely solely on § 285 to award expert fees. *See Amsted Indus. Inc. v. Buckeye Steel Castings Co.*, 23 F.3d 374, 376-77 (Fed. Cir. 1994). Section 285 encompasses attorney's fees, and expert witness fees fall under 28 U.S.C. § 1920 subject to 28 U.S.C. § 1821's limitations. *Id.* at 377. However, the court has discretion under § 285 to award reasonable expert witness fees in excess of the attendance fee specified in 28 U.S.C. § 1821. *Id.* The court may exercise its inherent power to shift expert fees to the losing party. However "[w]ithout a finding of bad faith or fraud whereby the very temple of justice has been defiled,

a court enjoys no discretion to employ inherent powers to impose sanctions." *Id.* at 378 (citations omitted). Moreover, "not every case qualifying as exceptional under section 285 will qualify for sanctions under the court's inherent power . . . [the] court must therefore assess whether this case goes sufficiently beyond exceptional within the meaning of section 285 to justify an award of expert fees as a sanction under the court's inherent power." *Id.* (citations omitted).

In *Amsted,* the Federal Circuit found the court abused its discretion by awarding expert fees, even where the non-prevailing party copied the patent, lacked a good faith belief of non-infringement and acted in a manner that repeatedly burdened the court. *Id* at 379. Although those actions supported enhanced damages and attorney's fees, the actions "did not amount to a fraud on the court or an abuse of the judicial process." *Id.* Here, the court previously awarded Liquid Dynamics $16,074.60 in fees related to experts under § 1920. While Vaughan's conduct is sufficient to support the award of enhanced damages and attorney's fees, it does not support a finding that Vaughan abused the judicial process. *See e.g., Vardon, 2003* U.S. Dist. LEXIS 5072, at *24. The request for expert witness fees is denied.

B. Costs

Section 285 permits recovery of expenses reasonably incurred in the litigation. *See e.g., Central Soya,* 723 F.2d at 1578. Liquid Dynamics seeks: (1) $81,490.10 for copies; (2) $4278.94 for postage and courier expenses; (3) $17,655.73 for Lexis and other database research expenses; (4) $9642.20

for travel expenses; (5) $14,791.15 for court reporters and videographers; and (6) $15,262.59 for miscellaneous costs.

Other than the generalized, blanket statements in its brief regarding the reasonableness of the entire fee request, Liquid Dynamics does not provide support showing the requested costs are reasonable. For example, Liquid Dynamics submits a voluminous exhibit of invoices, but no explanation as to why travel costs were reasonable or even identification of "miscellaneous" costs. *See* Mot. at Ex. 31. Nor does Liquid Dynamics identify which invoices pertain to specific costs. In addition, some of the documentation is illegible. In any event, the court previously awarded Liquid Dynamics $8268.21 for court reporter fees and $27,655.41 for exemplification and copying costs under § 1920. Liquid Dynamics fails to establish that additional costs should be awarded.

IV. 28 U.S.C. § 1927

As an additional basis for fees, Liquid Dynamics contends Vaughan's litigation misconduct multiplied the proceedings under 28 U.S.C. § 1927. Section 1927 provides an attorney who multiplies proceedings unreasonably and vexatiously may be required by the court to personally satisfy the excess costs, expenses and attorney's fees reasonably incurred because of misconduct. "To be liable under section 1927, counsel must have engaged in serious and studied disregard for the orderly process of justice," and "it is not sufficient that the claim be found meritless; the claim must be without a plausible legal or factual basis and lacking in justification." *Knorr Brake Corp. v. Harbil, Inc.*, 738 F.2d

223, 226-27 (7th Cir. 1984) (internal citations omitted). While Vaughan engaged in litigation misconduct, its claims were not without plausible basis. Further, the court has taken Vaughan's multiplication of proceedings into account by enhancing damages and finding the case is exceptional, warranting attorney's fees. The request for § 1927 sanctions is inappropriate under all the circumstances.

CONCLUSION

For the foregoing reasons, Liquid Dynamics' motion for attorney's fees and non-taxable costs is granted in part. Liquid Dynamics is awarded $1,501,239.80 in attorney's fees.

May 12, 2005

ENTER:

s/ Suzanne B. Conlon
Suzanne B. Conlon
United States District Judge

Appendix B

UNITED STATES DISTRICT COURT,
NORTHERN DISTRICT OF ILLINOIS

01 C 6934

5/12/05

LIQUID DYNAMICS CORP.

vs.

VAUGHAN, INC.

ORDER

Plaintiff's motion for attorney's fees and non-taxable costs [253-1] is granted in part. The judgment entered 11/15/04 [208-1], as amended by the court on 02/22/05 [260-1] and 03/22/05 [285-1], is further amended to award Liquid Dynamics $1,501,239.80 in attorney's fees pursuant to 35 U.S.C. § 285. ENTER MEMORANDUM OPINION AND ORDER.

s/ Suzanne B. Conlon

APPENDIX C — MEMORANDUM OPINION AND ORDER OF THE UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF ILLINOIS, EASTERN DIVISION DATED MARCH 22, 2005

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

No. 01 C 6934

Suzanne B. Conlon, Judge

LIQUID DYNAMICS CORPORATION,

Plaintiff,

v.

VAUGHAN COMPANY, INC.

Defendant.

MEMORANDUM OPINION & ORDER

Liquid Dynamics Corporation ("Liquid Dynamics") sued Vaughan Company, Inc. ("Vaughan") for infringement of U.S. Patent No. 5,458,414 ("the '414 patent") pursuant to 35 U.S.C. § 271 *et seq.* Specifically, Liquid Dynamics claimed Vaughan's "RotaMix" commercial mixing system used the invention described in the '414 patent to prevent settling and separation of liquid and solid components stored in slurry tanks. Vaughan counterclaimed for invalidity and inequitable conduct.

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Jury trial commenced on October 18, 2004. Vaughan's motion for judgment as a matter of law at the close of Liquid Dynamics' case, and both parties' motions for judgment as a matter of law at the close of evidence, were denied. Dkt. Nos. 200, 206. On October 25, 2004, the jury returned a $1,183,722.00 verdict in Liquid Dynamics' favor on the willful infringement and invalidity claims. Dkt. No. 206. Vaughan's renewed motions for judgment as a matter of law, a new trial, and to amend the answer and counterclaims to conform to the evidence were denied. Dkt. No. 213. On November 12, 2004, the court granted Liquid Dynamics' motion for judgment as a matter of law on the inequitable conduct claim. Dkt. No. 207. Final judgment was entered November 15, 2004. Dkt. No. 208.

Liquid Dynamics moves to amend the judgment to include enhanced damages under 35 U.S.C. § 284. Specifically, Liquid Dynamics asserts that an award of enhanced damages in the amount of $2,367,444, trebling the $1,183,722 compensatory damages award, is warranted.

DISCUSSION

The court may increase damages up to three times the jury award. *See* 35 U.S.C. § 284; *Read Corp. v. Portec, Inc.*, 970 F.2d 816, 826 (Fed. Cir. 1992). "Determining whether an award of enhanced damages is merited is a two-step process: (1) the jury must determine whether an infringer is guilty of conduct warranting increased damages; and (2) the court determines, in its discretion, whether, and to what extent, to increase the damages award based upon the totality of the circumstances." *Aero Prods. Int'l, Inc. v. Intex*

Recreation Corp., No. 02 C 2590, 2004 U.S. Dist. LEXIS 13453, *3 (N.D. Ill. July 15, 2004), *citing Jurgens v. CBK, Ltd.*, 80 F.3d 1566, 1570 (Fed. Cir. 1996). A jury finding of willful infringement satisfies the first step, and "upon a finding of willful infringement, a trial court should provide reasons for not increasing a damages award . . ." *Id.; see also Tate Access Floors v. Maxcess Techs.*, 222 F.3d 958, 972 (Fed. Cir. 2000). Nevertheless, "[a] finding of willfulness supports but does not mandate a damages enhancement. The question is the egregiousness of [Vaughan's] conduct considering all the facts and circumstances." *Amsted Ind., Inc. v. Buckeye Steel Castings Co.*, No. 88 C 0924, 1990 U.S. Dist. LEXIS 16657, *5 (N.D. Ill. Dec. 6, 1990); *see also Knorr-Bremse v. Dana Corp.*, 383 F.3d 1337, 1342-43 (Fed. Cir. 2004).

Specific factors to consider include: (1) whether Vaughan deliberately copied Liquid Dynamics' patented design; (2) whether Vaughan, when it knew of the '414 patent, investigated the patent's scope and formed a good-faith belief that its device was non-infringing; (3) Vaughan's behavior as a litigant; (4) Vaughan's size and financial condition; (5) the closeness of the case; (6) the duration of Vaughan's misconduct; (7) Vaughan's remedial actions; (8) Vaughan's motivation for harm; and (9) whether Vaughan attempted to conceal its misconduct. *See Read*, 970 F.2d at 827.

A. Deliberate Copying

The evidence submitted at trial supports a finding that Vaughan deliberately copied the '414 patent. For example, the evidence showed Liquid Dynamics began working on an Augusta, Georgia project in 1999. *See* Tr. 121, 124-25. The

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Augusta project was a privately negotiated deal, as opposed to a public bidding process. *See* Tr. 124. One of Liquid Dynamics' employees, Richard Behnke, worked on the project and participated in price quotations. *See* Tr. 121-22, 124-26. Vaughan hired Behnke soon after Liquid Dynamics terminated Behnke's employment. *See* Tr. 125, 346. Behnke worked on engineering drawings for Vaughan, and the drawings incorporated the same nozzle location, orientation, and floor-mounted system as Liquid Dynamics' Augusta drawings. *See* Tr. 350-51, 353-55; Mot. Exs. 6-10. One of Vaughan's witnesses, Glenn Dorsch, testified he had no knowledge of the Augusta project until Behnke was hired, and Vaughan never installed a floor-mounted mixing system prior to bidding on the Augusta project in early 2000. *See* Tr. 350-51, 356-57, 360. The Augusta project was awarded to Vaughan. *See* Tr. 127.

Further, Vaughan incorporated the Augusta drawings into its engineering manual as a template for other tanks. *See* Tr. 356-365; Mot. Exs. 6-7, 11. Finally, in submitting its engineering proposal for a Lewiston, Minnesota project, Vaughan certified that the Vaughan system would meet the bid specification, which required the substantially helical flow pattern covered by the '414 patent. *See* Tr. at 365-67; Mot. Exs. 12-13. Together, the evidence supports a finding that Vaughan deliberately copied Liquid Dynamics' patented design.

Vaughan contends its engineering submission for the Lewiston project noted its dual nozzle arrangement would produce only a rotational flow, and thus highlighted an exception to the performance specification. *See* Tr. 366-69.

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Vaughan argues it also made explicit exceptions to other bid specifications that required a rotating toroid or helical flow pattern. *See* Resp. Ex. 7. Vaughan may offer a scintilla of evidence in its favor, however most of its arguments and characterizations are unsupported. *See* Resp. at 3-7. Further, the jury considered Vaughan's evidence pertaining to deliberate copying when it rendered its willful infringement verdict.[1] The evidence sufficiently supports the jury's determination and a finding of deliberate copying. Accordingly, the first factor weighs strongly in Liquid Dynamics' favor.

---

1. The jury was instructed: "To prove willful infringement, Liquid Dynamics must persuade you that it is 'highly probable' that Vaughan's infringement was willful. Specifically, Liquid Dynamics must demonstrate that: (1) Vaughan had actual knowledge of the '414 patent; and (2) Vaughan had no reasonable basis for believing that the accused installations do not infringe the '414 patent or that the '414 patent was invalid or unenforceable. In deciding whether Vaughan committed willful infringement, you must consider all of the facts, which include but are not necessarily limited to the following: (1) whether Vaughan intentionally copied Liquid Dynamics' slurry mixing apparatuses that are covered by the '414 patent; (2) whether Vaughan, when it knew of Liquid Dynamics' patent protection, investigated the scope of the patent and formed a good faith belief that the patent was invalid or unenforceable or that it was not infringed; (3) whether Vaughan made a good faith effort to avoid infringing the patent; and (4) whether Vaughan relied on a legal opinion that appeared to it to be well-supported and believable and that advised Vaughan that the accused apparatuses did not infringe the '414 patent or that the '414 patent was invalid or unenforceable. Mot. Exs. 15, 54.

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B. Good Faith Belief of Non-Infringement

Vaughan contends it possessed a good faith belief of non-infringement because in August 2000 its patent attorney, Ward Brown, determined Vaughan's proposed systems would not infringe the '414 patent. *See* Tr. 1218-35. Brown, a member of Vaughan's trial team, recounted his opinion for the jury. *Id.* Reliance on legal advice may evidence good faith. *See e.g., SRI Int'l, Inc. v. Advanced Tech. Labs., Inc.,* 127 F.3d 1462, 1465 (Fed. Cir. 1997). Nevertheless, the jury found Vaughan wilfully infringed the '414 patent. Presumably, the jury disregarded Brown's testimony, resolved credibility determinations in Liquid Dynamics' favor, and rejected Vaughan's good faith defense. *See Amsted,* 1990 U.S. Dist. LEXIS 16657 at *6. The jury's determination was reasonable, given Brown's bias and interest in the case's outcome, and was supported by sufficient evidence, given the evidence of deliberate copying. Therefore, the second factor weighs slightly in Liquid Dynamics' favor.

C. Litigation Behavior

Liquid Dynamics asserts Vaughan's litigation behavior warrants enhanced damages. In support, Liquid Dynamics points to the deposition testimony of a Vaughan witness, the insufficiency of Vaughan's discovery production, and Vaughan's examinations at trial that, according to Liquid Dynamics, were wasteful of the court's and jury's time. These arguments do not support imposition of an enhanced damages award and they are disregarded. However, the record supports a finding that Vaughan's behavior as a litigant was inappropriate. The third factor weighs heavily in Liquid Dynamics' favor.

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On *three* occasions, Vaughan attempted to introduce untimely expert opinion in violation of the court's scheduling order. *See* Dkt. Nos. 44, 74, 188. The court was required to review and dissect numerous documents, particularly with respect to Vaughan's motions *in limine,* to identify and reject the untimely opinions.[2] Vaughan's conduct wasted judicial time and resources and placed an unnecessary and unreasonable burden on Liquid Dynamics.

Vaughan also disregarded the court's order granting its motion for leave to file an amended answer, affirmative defenses and counterclaims to add *specific,* newly discovered claims. Upon filing its answer, Vaughan included claims not disclosed to the court or Liquid Dynamics in its motion to amend. The court found "without prior leave of court, Vaughan attempts to inject a new inequitable conduct claim into a complex case without sufficient time for discovery," and struck the unauthorized affirmative defenses and counterclaims. *See* Dkt. No. 44-1. Vaughan's disingenuous conduct again unnecessarily burdened Liquid Dynamics and this court.

Two years after discovery closed, Vaughan issued an untimely deposition subpoena, without leave of court,

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2. In striking the expert testimony submitted in support of Vaughan's motion *in limine,* the court held "Vaughan's attempt to submit new opinion testimony by calling it 'fact' and trying to squeeze it under the parameters of generalized statements from the May 2002 report is appalling. The Dorsch affidavits are replete with inappropriate new opinions . . . It is disingenuous for Vaughan to assert generalized statements in the Dorsch/Keeran report . . . cover his elaboration more than two and a half years after the close of discovery." Dkt. No. 188 at 28-29.

without prior notification to opposing counsel, and with only four business days notice. The court granted Liquid Dynamics' emergency motion for a protective order and admonished "this is unreasonable and abusive conduct warranting sanctions if repeated by either party." *See* Dkt. No. 135-1. Vaughan admits it was "rightly chastised when the Court quashed the subpoena." *See* Resp. at 12.

When Liquid Dynamics moved to recover costs after its successful trial verdict, Vaughan argued Liquid Dynamics should not recover costs for 23 allegedly unnecessary depositions. The court found Vaughan's argument disingenuous given Vaughan's representation, when it sought deposition transcript costs after successfully moving for summary judgment, that depositions for 22 of the *same witnesses* were necessary. *See* Dkt. 96-1, 264-1 at 2.

Vaughan's irresponsible litigation behavior continues. The court, on its own motion and due to the unavailability of complete trial transcripts at the time of original filing, ordered the parties to supplement their briefs with specific citations to record evidence that supports each argument. *See* Dkt. 259-1. In its response brief, Vaughan argues:

> LD asserts that Vaughan never denied copying, despite the huge amount of evidence Vaughan introduced proving the differences between its designs and anything taught in the '414 patent: the use of fixed double nozzles (instead of rotatable single nozzles), placed high in the tank (instead of close to the floor), inward directed nozzles (instead of outward directed) to create

> turbulence at the tank center, placement of the sump in the tank center to draw the tank contents *inward* at the intersection of the tank floor and tank centerline (rather than *outward* as the claims require), and others. **[Trial Trans., p. 41]**.

Resp. at 3 (bolded text added). The *single* page Vaughan cited not only fails to support the assertion, it does not constitute evidence. Indeed, the record at page 41 constitutes a portion of Vaughan's counsel's opening statement. Vaughan's egregious pattern of inappropriate conduct unreasonably proliferated this litigation and wasted judicial resources. Accordingly, Vaughan's blatant disregard for the court's and Liquid Dynamics' time and resources supports an enhanced damages award.

D. Size and Financial Condition

Liquid Dynamics contends Vaughan's size and financial condition is sufficient to satisfy an enhanced damages award because: (1) in 2001, Vaughan retained earnings in the amount of $5,077,508, a $1,357,486 growth from 1999; (2) a recent D&B report shows Vaughan's net worth is $6,058,911 and its credit rating is very high; and (3) Vaughan's earnings in 2003 were $18,790,813, and its projected 2004 earnings were approximately $19,500,000. Mot. at Exs. 32-34. Vaughan does not challenge the accuracy of Liquid Dynamics' evidence. Instead, Vaughan contends it is a small, family-held company in rural Washington and "[a]lthough Vaughan is slightly larger than [Liquid Dynamics] its sales of mixing systems in the relevant time period were minimal in comparison to [Liquid Dynamics]." Vaughan's arguments are

irrelevant to its ability to satisfy an enhanced damages award. The fourth factor weighs in Liquid Dynamics' favor.

E. Closeness of Case

Vaughan argues its successful summary judgment motion, reversed by the Federal Circuit in a 2-1 decision, demonstrates this was an extremely close case. *See Liquid Dynamics Corp. v. Vaughan Company, Inc.*, 355 F.3d 1361 (Fed. Cir. 2004). Liquid Dynamics responds this was not a close case because the jury returned a verdict in Liquid Dynamics' favor on all issues, and the court granted Liquid Dynamics' Rule 52(c) motion at the close of Vaughan's inequitable conduct case. Both parties present valid arguments. Accordingly, the fifth factor – closeness of the case – does not strongly favor either party.

F. Motivation for Harm

Vaughan argues it had no motivation to harm Liquid Dynamics because Larry Vaughan, Vaughan's acting president, testified regarding the parties' cordial relationship, that Vaughan wished to retain Liquid Dynamics' business and that his company would never infringe another company's patent. *See* Tr. 1056-57, 1061-62. The jury evidently rejected Larry Vaughan's self-serving testimony. In any event, Vaughan's intent to harm is reflected by evidence, proffered by its own damages expert, that Vaughan would have incurred a maximum cost of $104,000 to utilize non-infringing alternatives. *See* Tr. 1198-20. Instead, Vaughan deliberately chose to infringe the patent and litigate. *See e.g., Exxon Chem. Patents, Inc. v. The Lubrizol Corp.*,

No. H-89-3203, 1994 U.S. Dist. LEXIS 17820, *6 (S.D. Tex. 1994) ("Lubrizol claimed at the trial on damages that it could have used non-infringing products instead of Exxon's formulation at little additional cost, but instead continued to infringe . . . Lubrizol showed no motive for its conduct other than to harm its major competitor"), *rev 'd on other grounds,* 64 F.3d 1553 (Fed. Cir. 1995). Therefore, the sixth factor weighs strongly in Liquid Dynamics' favor.

G. Remaining Factors

None of the three remaining factors weigh in Vaughan's favor. First, Liquid Dynamics contends Vaughan's efforts to conceal its misconduct are evidenced by the minor details Vaughan added to its RotaMix system in an attempt to camouflage its willful infringement. Specifically, Liquid Dynamics asserts Vaughan simply added an additional nozzle to the lower nozzle of Liquid Dynamics' commercial embodiment of its patented system. Second, with respect to the duration of misconduct, Liquid Dynamics contends: (1) Vaughan admittedly knew of the '414 patent before it began infringing; (2) Vaughan infringed for over a year and a half before Liquid Dynamics filed suit; (3) Vaughan's infringement continued after the lawsuit was filed and before discovery closed; and Vaughan's infringement began in 1999, yet it failed to retain a patent lawyer until after it was "caught" in connection with the Augusta, Georgia project. Finally, Liquid Dynamics contends Vaughan has not disclosed evidence of any remedial actions, such as the sale or offer for sale of any alternative, non-infringing floor-mounted mixing system.

Vaughan does not offer any substantive responses to these arguments. Vaughan's only assertion, other than to baldly deny the allegations, is that it "is no longer designing Rotamix systems having multiple nozzles within the protected band and has thus taken appropriate remedial action pending the appeal of the judgment." Vaughan's assertion is completely unsupported and, given an unfavorable liability finding and the court's recent issuance of a permanent injunction, *see* Dkt. No. 260-1, lacks merit.

CONCLUSION

After considering all facts and circumstances, particularly Vaughan's behavior as a litigant, the court in its discretion finds enhanced damages are appropriate. Liquid Dynamics is awarded $2,367,444 in enhanced damages pursuant to 35 U.S.C. § 284.

March 22, 2005

ENTER:

s/ Suzanne B. Conlon
United States District Judge

Appendix C

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS

01 C 6934

Suzanne B. Conlon

LIQUID DYNAMICS

vs.

VAUGHAN

ORDER

Liquid Dynamics' motion to amend the judgment to include enhanced damages [225-1] is granted. The judgment entered 11/15/04 [208-1], as amended by the court on 02/22/05 [260-1], is further amended to add an award to Liquid Dynamics of $2,367,444 in enhanced damages pursuant to 35 U.S.C. § 284. ENTER MEMORANDUM OPINION AND ORDER.

DATE: 3/22/2005

s/ Suzanne B. Conlon

APPENDIX D — ORDER OF THE UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF ILLINOIS DATED FEBRUARY 22, 2005

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS

01 C 6934

Suzanne B. Conlon

LIQUID DYNAMICS

vs.

VAUGHAN

ORDER

Plaintiff's motion to register the judgment in other districts [227-1] is denied, and its motions for prejudgment and post-judgment interest, a permanent injunction and an amended judgment [228-1, 228-2, 226-1, 230-1] are granted. The judgment entered November 15, 2004 [208-1] is amended to read "It is hereby ordered and adjudged that judgment is entered for plaintiff Liquid Dynamics Corp. and against defendant Vaughan Co. Inc. in the amount of $1,183,722.00. Liquid Dynamics is awarded prejudgment interest in the amount of $139,604.34 and post-judgment interest at a *per diem* rate of $80.10 for each day after November 15, 2004 until the date of payment in full of the $1,183,722.00 award. The court permanently enjoins Vaughan, its officers, agents, servants, employees and attorneys, and parties in active concert or participation with

them, from directly or indirectly infringing Claims 1 and 8 of U.S. Patent No. 5,458,414, until the patent expires, by making, using, offering to sell, importing, or selling mixing systems employing the design(s), placement(s) and orientation(s) of nozzle assemblies used by the 47 mixing systems found to infringe Claims 1 and 8 of U.S. Patent No. 5,458,414, as well as colorable imitations of the infringing systems. Vaughan is ordered to give notice of the permanent injunction to its officers, agents, servants, employees and attorneys, and to those parties in active concert or participation with them in the manufacture, marketing, sales and use of mixing systems enjoined by this permanent injunction. The court retains jurisdiction over the parties for enforcement of the permanent injunction and adjudication of any contempt proceedings or issues arising under this order." ENTER MEMORANDUM OPINION AND ORDER.

DATE: 2/22/2005

s/ Suzanne B. Conlon

APPENDIX E — ORDER OF THE UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF ILLINOIS, EASTERN DIVISION DECIDED NOVEMBER 12, 2004 AND DOCKETED NOVEMBER 15, 2004

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
Eastern Division

Case Number: 01 C 6934

LIQUID DYNAMICS CORP.

v.

VAUGHAN CO., INC.

JUDGMENT IN A CIVIL CASE

Jury Verdict. This action came before the Court for a trial by jury. The issues have been tried and the jury rendered its verdict.

IT IS HEREBY ORDERED AND ADJUDGED that judgment is entered for plaintiff Liquid Dynamics Corp. and against defendant Vaughan Co., Inc. in the amount of $1,183,722.00.

Michael W. Dobbins, Clerk of Court

s/ Chris Burton
Chris Burton, Deputy Clerk

Date: 11/12/2004

APPENDIX F — ORDER OF THE UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF ILLINOIS DATED OCTOBER 25, 2004

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS

01 C 6934

Suzanne B. Conlon

LIQUID DYNAMICS

vs.

VAUGHAN CO.

ORDER

Jury trial held. Plaintiff rests its rebuttal case. The parties' motions for judgment at the close of the evidence are denied. Defendant's motion to strike the expert testimony of Dr. Richard Lueptow and Edward Gillette and plaintiff's motion to strike the testimony of Ward Brown are denied. Jury deliberates. Verdict returned finding that plaintiff has proven defendant has infringed claims of the '414 patent and that defendant's infringement was willful, and that defendant has not proven that any claims of the '414 patent are invalid. Jury awards plaintiff damages in the amount of $1,183,722.00 because of defendant's infringement of the '414 patent. Judgment entered on jury's verdict. Bench trial on inequitable conduct set on November 12, 2004 at 9:30 am.

DATE: 10/25/2004

s/ Suzanne B. Conlon

APPENDIX G — MEMORANDUM OPINION AND ORDER OF THE UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF ILLINOIS, EASTERN DIVISION DATED SEPTEMBER 30, 2004

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

No. 01 C 6934

Suzanne B. Conlon, Judge

LIQUID DYNAMICS CORPORATION,

Plaintiff,

v.

VAUGHAN COMPANY, INC.,

Defendant.

MEMORANDUM OPINION & ORDER

Liquid Dynamics Corporation ("Liquid Dynamics") sues Vaughan Company, Inc. ("Vaughan") for infringement of U.S. Patent No. 5,458,414 ("the '414 patent") pursuant to 35 U.S.C. § 271 *et seq.* Liquid Dynamics sells a commercial mixing system called "JetMix." JetMix uses the invention described in the '414 patent to prevent settling and separation of liquid and solid components stored in slurry tanks. Liquid Dynamics claims Vaughan's competitive product, "RotaMix," uses mixing systems covered by the '414 patent.

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Vaughan counterclaims for invalidity and inequitable conduct. The court granted Vaughan's summary judgment motion on non-infringement of the '414 patent. *Liquid Dynamics Corp. v. Vaughan Company, Inc.*, No. 01 C 6934, 2002 U.S. Dist. LEXIS 14102 (N.D. Ill. Jul. 31, 2002). The Federal Circuit reversed and remanded the case for trial. *Liquid Dynamics Corp. v. Vaughan Company, Inc.*, 355 F.3d 1361 (Fed. Cir. 2004). Both parties move *in limine* to bar evidence at trial.

DISCUSSION

I. Standard of Review

Evidence is excluded on a motion *in limine* only if the evidence is clearly inadmissible for any purpose. *See Hawthorne Partners v. AT&T Technologies*, 831 F. Supp. 1398, 1400 (N.D. Ill. 1993). Motions *in limine* are disfavored; admissibility questions should be ruled upon as they arise at trial. *Id.* Accordingly, if evidence is not clearly inadmissible, evidentiary rulings must be deferred until trial to allow questions of foundation, relevancy and prejudice to be resolved in context. *Id.* at 1401. Denial of a motion *in limine* does not indicate evidence contemplated by the motion will be admitted at trial. Instead, denial of the motion means the court cannot or should not determine whether the evidence in question should be excluded before trial. *United States v. Connelly*, 874 F.2d 412, 416 (7th Cir. 1989).

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II. Liquid Dynamics' Motions *in Limine*

A. Limit Expert Testimony to Disclosed Opinions

1. Liquid Dynamics' Arguments

Liquid Dynamics moves *in limine* to exclude any expert testimony that is new and untimely disclosed. Specifically, Liquid Dynamics asserts that on May 1, 2002, the last day for disclosure of Rule 26(a)(2) rebuttal expert reports, Vaughan submitted a report signed by employees Glen Dorsch and Kent Keeran ("the Dorsch/Keeran report"). On June 10, 2002, the court struck Section III, a purported computational flow dynamics ("CFD") study on a system in Plymouth, Indiana and Section IV, a purported CFD study on another patent, as new and untimely expert opinion. Liquid Dynamics argues that all trial testimony pertaining to Sections III or IV of the Dorsch/Keeran report must be excluded. Liquid Dynamics further contends any new opinion testimony by Dorsch or Keeran regarding infringement or critiques of CFD simulations conducted by Liquid Dynamics' expert, Dr. Lueptow, beyond that disclosed in the original report should also be excluded. Finally, Liquid Dynamics asserts Vaughan should be limited to offering either Dorsch or Keeran to testify about the report in accordance with this court's standing order limiting each party to only one expert witness per subject.

2. Vaughan's Arguments

Vaughan responds that it does not intend to present expert testimony from both Dorsch and Keeran. However, Vaughan

asserts both witnesses worked directly on the design, analysis and implementation of some or all of Vaughan's accused systems. Thus, both will likely be offered at trial for fact testimony. With respect to Sections III and IV of the report, Vaughan affirms it will not violate the court's order. However, Vaughan contends it originally submitted Sections III and IV in the event Liquid Dynamics' experts testify, despite the absence of any such opinions in their reports, that prior art did not generate a substantial helical flow. If Liquid Dynamics does not offer new testimony, Vaughan will not offer Sections III and IV barred by the court's order.

3. Findings

Fed. R. Civ. P. 26(a) requires disclosure of expert witnesses and their written reports. The rule provides, "these disclosures shall be made at the times and in the sequence directed by the court." Fed. R. Civ. P. 26(a)(2)(c). Failure to comply with Rule 26 precludes a party from using at trial expert testimony that was not timely or fully disclosed. Fed. R. Civ. P. 37(c)(1). The sanction of exclusion is mandatory and automatic unless the party can show its Rule 26(a) violation was either justified or harmless. *Finley v. Marathon Oil Co.*, 75 F.3d 1225, 1230 (7th Cir. 1996). The court previously struck Sections III and IV of the Dorsch/Keeran report as untimely disclosed expert opinion. The motion *in limine* to exclude any evidence or testimony relating to Sections III and IV of the Dorsch/Keeran report must be granted. Further, the motion *in limine* to exclude all new opinion testimony by Dorsch or Keeran regarding infringement or critiques of Lueptow's CFD simulations beyond that disclosed in the original Dorsch/Keeran report

is granted. Finally, this court's "Standing Order Establishing Pretrial Procedure" limits each party to one expert witness per topic. Liquid Dynamics' motion to preclude Vaughan from presenting both Dorsch and Keeran as experts is moot in light of Vaughan's representation that it will not do so. The motion *in limine* to preclude both witnesses from testifying must be denied.

B. Expert Testimony of Norcross and Bathija

1. Liquid Dynamics' Arguments

Liquid Dynamics seeks to exclude expert testimony by Prakash Bathija, who is on Vaughan's witness list. Liquid Dynamics asserts Bathija is the author of an article entitled "Jet Mixing." However, Bathija was not timely disclosed as an expert witness. The court is asked to limit his testimony to authentication of the article because any testimony beyond authentication would amount to expert opinion. Further, Liquid Dynamics seeks to exclude undisclosed expert opinion testimony from Ken Norcross, also on Vaughan's witness list. On July 18, 2002, the court struck Norcross' summary judgment declaration as untimely and inappropriate expert opinion not disclosed prior to April 1, 2002, the deadline for disclosure of expert reports. However, Liquid Dynamics is concerned Vaughan will elicit expert opinion from Norcross at trial under the guise of lay opinion.

2. Vaughan's Arguments

Norcross is a former vice-president and director of technology at U.S. Filter Jet-Tech. Vaughan asserts Norcross

was identified well before the close of discovery as a witness having knowledge regarding prior art systems. Vaughan contends the court's July 18, 2002 order striking Norcross' declaration acknowledged Norcross' knowledge of certain prior art systems. Vaughan proposes to call Norcross as a lay witness having personal knowledge of prior art, but not as an expert witness. Vaughan assures the court Norcross' testimony is purely factual in nature and he will not be asked to opine on flow patterns. Finally, Vaughan indicates it will not call Bathija as a witness at trial.

3. Findings

Liquid Dynamics' motion regarding Bathija is moot in light of Vaughan's representation that Bathija will not be called to testify. As to Norcross, the July 18, 2002 order specifically ruled that Norcross' conclusory opinions in his summary judgment declaration regarding helical flow patterns of prior art mixing systems were "not lay witness opinion under Fed. R. Evid. 702. The '414 patent and purported prior art helical flow patterns have been the subject of expert testimony by both parties. The analysis of a system's flow patterns is based on technical and scientific data." Further, Norcross' summary judgment declaration lacked sufficient foundation to establish his opinions regarding the validity of the '414 patent and the mixing industry's prior use of the '414 patent's claims were based on personal knowledge. Accordingly, the court struck Norcross' inappropriate and untimely expert testimony. Contrary to Vaughan's assertions, the court did not rule that Norcross is knowledgeable regarding certain prior art systems. Rather, the court indicated four paragraphs of his declaration that

explained U.S. Filter Jet-Tech documents were apparently based on personal knowledge.

With proper foundation, lay opinion testimony may be admissible to assist the jury or court understand the factual issues. *Stagman v. Ryan,* 176 F.3d 986, 995-96 (7th Cir. 1999). However, Fed. R. Evid. 701 provides lay witnesses may not opine regarding scientific, technical or other specialized knowledge within the scope of Fed. R. Evid. 702. Lay opinion testimony is "not to provide specialized explanations or interpretations that an untrained layman could not make if perceiving the same acts or events." *U.S. v. Conn,* 297 F.3d 548, 554 (7th Cir. 2002). The motion *in limine* regarding Norcross is granted in part. Norcross may not testify to the flow pattern information contained in his summary judgment declaration. With proper foundation evidencing personal knowledge, Norcross' testimony regarding prior art systems is not clearly inadmissible for all purposes. The extent to which Norcross may offer lay opinion testimony not based on scientific, technological or other specialized knowledge, however, is unclear. The court must reserve ruling on the admissibility of Norcross' lay opinion testimony until trial. The parties will not refer to Norcross' opinions in opening statements, through questioning witnesses, or otherwise in the jury's presence without prior court authorization.

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C. Expert Testimony of Breidenthal

1. Liquid Dynamics' Arguments

Liquid Dynamics seeks to exclude the testimony of Dr. Robert Breidenthal, an expert witness who submitted two reports on Vaughan's behalf and was deposed during discovery. Liquid Dynamics contends Breidenthal's opinions regarding patent validity and infringement should be barred because they are based on an improper claim construction rejected by the Federal Circuit. Liquid Dynamics argues Breidenthal's opinions are expressly based on an interpretation requiring the claim term "substantially helical" to conform to Figure 6 of the '414 patent. In contrast, the Federal Circuit construed the term "substantially helical" to encompass "all flow patterns that are generally, though not necessarily perfectly, spiral and that fill much, though not necessarily all, of the tank's volume." *Liquid Dynamics*, 355 F.3d at 1369. This construction expressly rejected any claim construction requiring the nearly perfect helix portrayed by Figure 6. The Federal Circuit held it is inappropriate to rely "on the written description of Figures 5 and 6 to import the limitation of a perfectly helical flow. There is no language in the claim requiring such a perfectly helical flow." *Id.* at 1368. Liquid Dynamics argues Breidenthal's two opinions and deposition testimony clearly illustrate his reliance on Figure 6 in his assessment of the Vaughan systems. According to Liquid Dynamics, Breidenthal's reliance on a false premise taints all of his disclosed opinions and renders them irrelevant and inadmissible.

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2. Vaughan's Arguments

Vaughan responds that Breidenthal may be called to testify to: (1) the teachings of the '414 patent to one of ordinary skill in the art; (2) whether the teachings of the patent provide information sufficient for one of ordinary skill in the art to practice the invention claimed, and specifically, to create in a storage tank the helical flow pattern required by the claims; and (3) whether the evidence proffered by Liquid Dynamics demonstrates all limitations of the '414 patent's claims. Vaughan argues Breidenthal's opinions are based on his review of the patent's teachings and the language of the patent claims. His opinions do not require strict adherence to the structure of Figure 6. Instead, Breidenthal's opinions recognize Figures 5 and 6 illustrate desirable flow patterns and describe a preferred embodiment. His opinion, whether the patent includes a description sufficient to teach one of ordinary skill in the art how to practice the invention, is independent of flow pattern. Breidenthal concludes the patent does not teach how to achieve any specified flow pattern let alone a substantially helical one. Because Breidenthal's opinions are not premised on an understanding that "substantial helical flow" requires precise adherence to Figure 6, his testimony is not rendered irrelevant or inadmissible by the Federal Circuit's claim construction.

3. Findings

Vaughan asked Breidenthal to opine whether: (1) the teachings of the '414 patent enable one skilled in the art to practice the invention; (2) Vaughan's configuration infringed the '414 patent's claims; and (3) Liquid Dynamics' experts

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Lueptow and Gillette properly construed the '414 patent claims. Breidenthal clearly relied on Figure 6 to answer those questions. His March 29, 2002 letter to Vaughan's counsel indicates Figures 5 and 6 represent "desirable flow patterns," and "the pitch of the helical flow pattern of FIG. 6 is presumably influenced by the ratio of the net radial to the net azimuthal momentum. The patent offers no teaching here." Breidenthal concludes the patent does not teach a specified flow pattern, particularly a substantially helical one. He further asserts a central issue to the infringement question concerns the helical flow path described in Claims 1 and 8, and states:

> Claim 1 refers to "a substantial helical flow path" and Claim 8 refers to "a substantially helical flow path." FIG. 6 illustrates a flow path where a fluid element completes 14 orbits about the minor axis over about half of a full torus. Thus FIG. 6 teaches that the helix should have a fine pitch, with many orbits about the minor axis during one rotation about the major axis. From FIG. 6, I estimate that the ratio of the characteristic transverse speed V to the characteristic azimuthal speed U is approximately 18. The transverse component completely dominates the azimuthal component of the flow. Therefore, the helix described by the Claims 1 and 8, is substantial.

Breidenthal then compares CFD simulations to Figure 6 of the '414 patent:

> Computational fluid dynamics simulations of Vaughan configurations by ADA Technology yield

> predicted particle trajectories that do not resemble FIG. 6 . . . This is evident in a comparison between FIG. 6 of the '414 patent and VA 2880-2891. The basic shapes of the flow paths are completely different. The Vaughan flows shown in these computations do not exhibit a substantial helix, in my view.

Breidenthal's April 20, 2002 letter to Vaughan's counsel comments:

> I believe one of average skill in the art would consider a "substantially helical flow path" that "substantially" fills the volume to imply a predominantly helical flow throughout most of the volume, as indicated in FIG. 6 of the '414 patent. In my view, none of the figures in Professor Lueptow's report resemble FIG. 6 of the '414 patent.

At his deposition, Breidenthal testified "the term substantially helical implies something like figure six . . ." and admitted he compared various Vaughan flows to Figure 6. Breidenthal Dep. at 88, 90, 95-96.

Bredeinthal relied on Figure 6 to opine on enablement; he concluded the patent does not teach how to achieve the results portrayed by Figure 6. He relied on Figure 6 to determine infringement; he concluded Vaughan's systems did not resemble Figure 6. He relied on Figure 6 to rebut Lueptow and Gillette's opinions; he concluded none of their figures resembled Figure 6. Vaughan argues that although

Bredeinthal relied on Figure 6, he did not require "strict conformance," rather he required "substantial" conformance because he used flexible phrases such as "*desirable* flow pattern," "*resemble* Figure *6*," "*something like . . .* Figure 6," and "*basic shapes* of the flow paths." Vaughan contends the use of these phrases indicates he understood the claim words must be read in light of their ordinary meaning, an approach consistent with the Federal Circuit's holding.

Irrelevant evidence is not admissible. Fed. R. Evid. 402. Relevant evidence is defined as "evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence." Fed. R. Evid. 401. Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, waste of time, and jury confusion. Fed. R. Evid. 403. Breidenthal's opinions rely extensively on Figure 6. In light of the Federal Circuit opinion, any probative value of Breidenthal's opinion is outweighed by the danger of unfair prejudice and jury confusion. Accordingly, the motion *in limine* to exclude Breidenthal's expert testimony must be granted.

D. Testimony of Attorney Sandler

1. Liquid Dynamics' Arguments

Liquid Dynamics seeks to exclude testimony from Ronald Sandler, Vaughan's patent attorney, who is offered to opine on the issue of materiality in support of Vaughan's inequitable conduct defense. Vaughan offers Sandler's

testimony that the sale of a sludge storage tank to a city in Indiana was material prior art that should have been disclosed during prosecution of the '414 patent. Liquid Dynamics argues Sandler needs a technical background in the relevant art, specifically fluid dynamics and waste treatment systems, to testify on materiality. Liquid Dynamics bases its argument on *Baxter Int'l v. McGaw, Inc.*, 149 F.3d 1321, 1328 (Fed. Cir. 1998) (materiality is "judged based upon the overall degree of similarity between the omitted reference and the claimed invention in light of the other prior art before the examiner"). Liquid Dynamics asserts Sandler admittedly does not have a technical background in the relevant art. In addition, because two of his three opinion letters were disclosed on an untimely basis, his opinion should be barred under Fed. R. Civ. P. 26(a) and 37(c)(1). Finally, Liquid Dynamics argues at a minimum Sandler's testimony should be heard by the court outside the jury's presence because inequitable conduct is an issue for the court, not the jury, to decide. *Paragon Podiatry Lab., Inc. v. KLM Labs., Inc.*, 984 F.2d 1182, 1190 (Fed. Cir. 1993).

2. Vaughan's Arguments

Vaughan responds Sandler, a former examiner for United States Patent and Trademark Office and a patent attorney with 40 years of practical experience prosecuting patent applications, would provide expert opinion testimony relevant to the determination of whether a "reasonable patent examiner" considers certain prior art references material. *Molins PLC v. Textron*, 48 F.3d 1172, 1179 (Fed. Cir. 1995) ("information is 'material' when there is a substantial likelihood that a reasonable examiner would have considered

the information important in deciding whether to allow the application to issue as a patent"). Vaughan asserts Sandler is not offered for his expertise in the technical field; rather, he is offered for his expertise and knowledge as an attorney and former patent examiner under Fed. R. Evid. 702. Vaughan further asserts its original disclosure of Sandler's expert report was timely. Sandler however, on his own volition, sent two rebuttal letters to Vaughan's litigation counsel responding to Liquid Dynamics' expert rebuttal reports. Vaughan states its counsel did not request the additional letters and produced them, not for the purpose of injecting untimely testimony, but out of an obligation to supplement discovery. Further, the letters do not offer new opinions. Rather, they reinforce Sandler's original opinions and reflect statements Sandler would make on cross or re-direct examination regarding Liquid Dynamics' rebuttal opinions. Vaughan argues there is no prejudice to Liquid Dynamics if the statements are offered at trial in strict rebuttal to cross-examination. Finally, Vaughan contends patent lawyers regularly testify at trial and patent legal experts are routinely allowed to offer expert opinion testimony on whether undisclosed prior art references are material. *See e.g., Yarway Corp. v. Env. Control USA, Inc.*, 775 F.2d 268, 274 (Fed. Cir. 1985); *Hebert v. Lisle Corp.*, 99 F.3d 1109, 1115 (Fed. Cir. 1996).

3. Findings

Sandler's testimony is not clearly inadmissible for all purposes. A patent lawyer may testify in a patent suit. *Endress + Hauser, Inc. v. Hawk Measurement Sys. Pty, Ltd.*, 122 F.3d 1040, 1042 (Fed. Cir. 1997). Sandler's lack of technical expertise goes to the weight of his testimony as opposed to

its admissibility. Indeed, the court has discretion to adopt the legal opinion as its own, find guidance from it, or disregard it completely. *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 983 (Fed. Cir. 1995). As a former patent examiner, his testimony is relevant to the "reasonable patent examiner" standard as applied to the materiality of undisclosed prior art. Moreover, Vaughan has asserted justification for producing two of Sandler's three opinion letters after the deadline for expert reports passed, and acceptable reasons why Liquid Dynamics will not be prejudiced if the letters are not excluded. Liquid Dynamics has been in possession of the two letters for years and the contents are not a surprise. The motion *in limine* must be denied.

However, "a patent case is complex and confusing enough for a jury without infusing evidence which has no relevance to the issues to be decided by that jury." *THK Am., Inc. v. NSK, Ltd.*, No. 90 C 6049, 1996 U.S. Dist. LEXIS 226, *4 (N.D. Ill. Jan. 9, 1996). Because evidence of inequitable conduct is effectively evidence of fraud, there is a danger the evidence will unnecessarily "spill over" to Liquid Dynamics' prejudice on issues that *are* before the jury. *Id.* at *4-5. For this reason, Sandler's testimony will be heard by the court outside the jury's presence. Counsel shall not refer to Sandler's testimony in the jury's presence.

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E. Reliance on Prior Art References and Testimony

1. Liquid Dynamics' Arguments

Liquid Dynamics asserts Vaughan recently produced a list of 70 prior art references that Vaughan may rely on at trial to show invalidity of the '414 patent. Liquid Dynamics argues that to rely on the prior art references, Vaughan must present expert testimony explaining element-by-element how each reference anticipates the '414 patent. However, Vaughan has not properly disclosed a witness skilled in the art to provide an explanation for each reference or the substance of purported testimony. The five individuals disclosed by Vaughan are: (1) Prakash Bathija, an author on one article; (2) Eric Mandt, an inventor on eight patents; (3) Mark Crump, an officer of Liquid Dynamics and inventor of the '414 patent; and (4)-(5) Glen Dorsch and Ken Norcross, whose proposed opinion testimony was previously stricken by the court. Specifically, Liquid Dynamics contends Bathija and Mandt were not disclosed as experts and Vaughan never disclosed the substance of their opinion testimony. Their testimony was therefore not timely disclosed. Crump is not an expert and at best may have personal knowledge of a few, but not all, references. Finally, the Dorsch and Norcross testimony was excluded as untimely pursuant to the court's June 22, 2002 order.

2. Vaughan's Arguments

Vaughan argues the notice produced was required pursuant to 35 U.S.C. § 282, mandating disclosure of prior art documents and witnesses at least 30 days before trial. In

any event, Vaughan contends all references of prior art in the notice were disclosed over two years ago during the original discovery period. Further, Vaughan contends Liquid Dynamics' position that "expert opinion" testimony is required for Vaughan's invalidity counterclaim is not supported by case law. Prior art documents may be explained by witnesses having personal knowledge of the prior art installations. Vaughan contends witnesses having personal knowledge of facts are sufficient because the technology of this case is relatively simple; all prior art references are easy to understand and consist mostly of drawings showing storage tanks and flow generators within the tanks. Therefore, expert opinion testimony is not required for the jury to appreciate whether a document shows the structural features as claimed in the '414 patent. The witnesses identified may be relied upon as prior inventors or as having personal knowledge of prior art.

3. Findings

Liquid Dynamics' motion places substantial reliance on *Koito Mfg. Co., Ltd. v. Turn-Key-Tech, LLC,* No. 03-1565, 2004 U.S. App. LEXIS 17896, *20-25 (Fed. Cir. Aug. 23, 2004). In *Koito,* the Federal Circuit reversed the district court's denial of Turn-Key's motion for judgment as a matter of law with respect to anticipation and obviousness. In denying Turn-Key's motion, the district court relied solely on Koito's reference to another patent application, the JP '082. Koito offered evidence of the JP '082 reference, but did not provide any testimony or other evidence that would "demonstrate to the jury how that reference met the limitations of the claims in the . . . patent, or how the

reference enabled one of ordinary skill in the art to practice the claimed invention." *Id.* at *21-22. Indeed, Koito never mentioned that reference at trial after submitting it into evidence. The Federal Circuit held the district court erred in finding Koito had provided substantial evidence to support the jury's finding of obviousness based solely on its evidence regarding the JP '082 reference. "We have consistently explained what is necessary to show anticipation by a given reference. Typically, testimony concerning anticipation must be testimony from *one skilled in the art* and must identify each claim element, state the witnesses' interpretation of the claim element, and explain in detail how each claim element is disclosed in the prior art reference. The testimony is insufficient if it is merely conclusory." *Id.* at *23 (emphasis added).

Koito rejected the notion that explanatory testimony relating to the JP '082 reference was unnecessary based on *Union Carbide Corp. v. American Can Co.*, 724 F.2d 1567 (Fed. Cir. 1991). *Id* at *24, n.4. In *Union Carbide*, the alleged infringer did not provide explanatory testimony regarding prior art references. However, the references and the patent, a simple method of dispensing plastic bags, were easily understandable and the patentee, instead of the infringer, provided explanatory analysis regarding prior art references. The patent in *Koito*, which taught a method of strengthening injection-molded plastics by cross-laminating layers of plastics, was "not an easily understandable patent," and therefore needed some explanatory testimony or other evidence to compare the prior art with the patent at issue.

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The court disagrees with Vaughan's assertion that the '414 patent is relatively simple because it relates to an apparatus for mixing sludge or slurry in a large storage tank. The '414 patent involves significant scientific and technical information that may not be easily understandable to the jury. Moreover, Vaughan relies on *Union Carbide* to support its assertion that expert testimony is not necessary when a patent is simple. Even in *Union Carbide,* where the expert testimony was not necessary due to the simplicity of the patent, the patentee presented explanatory testimony. In any event, to prove anticipation or obviousness, Vaughan must provide testimony "from *one skilled in the art* and must identify each claim element, state the witnesses' interpretation of the claim element, and explain in detail how each claim element is disclosed in the prior art reference." *Koito* at *23 (emphasis added). The concept "one skilled in the art" is a theoretical construct used to determine obviousness. It does not necessarily refer to a particular individual or an expert. *Endress,* 122 F.3d at 1042. An expert witness may not always be one skilled in the art, and one skilled in the art may not necessarily be an expert witness. *Id.*; *see also, Dayco Prods. v. Total Containment, Inc.,* 258 F.3d 1317, 1324 (Fed. Cir. 2001) ("our objective is to interpret the claims from the perspective of one of ordinary skill in the art, not from the viewpoint of counsel or expert witnesses"). Liquid Dynamics' argument that Vaughan must present "expert testimony" for explanation is incorrect. None of the identified witnesses may testify as experts. However, if Vaughan proffers appropriate foundation establishing Mandt, Dorsch, Norcross and Crump are skilled in the art, they may testify about their personal knowledge of prior art. The motion *in limine* must be denied.

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III. Vaughan's Motions *in Limine*

A. Willful Infringement

1. Vaughan's Arguments

Vaughan seeks to bar any testimony relating to Liquid Dynamics' claim of willful infringement. According to Vaughan, Liquid Dynamics' complaint and exhibit list show Liquid Dynamics' intent to establish Vaughan willfully infringed at least one claim of the '414 patent. Vaughan argues the state of mind of its decisionmakers is irrelevant because, as a matter of law, there can be no finding of willful infringement. Vaughan argues this court's grant of summary judgment and the Federal Circuit's dissenting opinion establish Vaughan has a substantial defense to infringement. According to Vaughan, the existence of a substantial defense establishes it had a good faith belief it would not infringe the '414 patent and a finding of willful infringement or enhanced damages under 35 U.S.C. § 384 would be inappropriate. Therefore, testimony relating to willful infringement would be irrelevant and prejudicial because of likely jury confusion. Vaughan argues admission of willfulness testimony would force Vaughan to waive the attorney-client privilege because evidence probative of Vaughan's state of mind may require testimony from Vaughan's attorneys who advised the company as to its potential defenses. Vaughan argues the exclusion of willfulness evidence in a trial on liability may ameliorate any risk of prejudice to Vaughan.

2. Liquid Dynamics' Arguments

Liquid Dynamics responds that this motion *in limine* is actually an inappropriate motion for summary judgment. Vaughan ignores cases holding that litigation history, such as this court's summary judgment decision and the appellate dissent, are not relevant to the state of mind of the infringer when the infringement began. Vaughan ignores a recent *en banc* Federal Circuit case flatly rejecting the argument that the existence of a substantial defense to infringement is *per se* sufficient to defeat liability for willful infringement. *Knorr-Bremse Systeme Fuer Nutzfahrzeuge GmbH v. Dana Corp.*, No. 01-1357, 2004 U.S. App. LEXIS 19185, at *26-27 (Fed. Cir. Sept. 13, 2004). Liquid Dynamics further argues Vaughan's attorney-client waiver argument is frivolous because Vaughan already disclosed its counsel's opinion during discovery. Liquid Dynamics contends the focus of willfulness is on the infringer's mental state, not the mental state of the attorney authoring the non-infringement opinion. Therefore, a member of the litigation team is wholly unnecessary and Vaughan may use other witnesses at trial.

3. Findings

Vaughan's reliance on *State Contracting & Eng'g Corp. v. Condotte America, Inc.*, 346 F.3d 1057 (Fed. Cir. 2003) is misplaced. In *State Contracting*, the district court ruled at the close of trial that infringement was not willful as a matter of law. The Federal Circuit affirmed the finding because defendants had a substantial defense to infringement. *Id.* However, in *State Contracting* there was no dispute defendants acted in good faith when they infringed the patent.

The facts of this case are very different. Whether Vaughan willfully violated the '414 patent is strongly contested. Even in *State Contracting,* the determination of willfulness was reserved until the end of trial. Vaughan presents no authority for excluding the willfulness issue from the trial. This court's initial grant of summary judgment and the Federal Circuit's dissenting opinion do not preclude a finding of willfulness at trial. The concept of a substantial defense to infringement providing *a per se* preclusion to a willfulness determination has been flatly rejected. *Knorr-Bremse,* 2004 U.S. App. LEXIS 19185, at *26-27. Moreover, a willfulness determination typically requires review of the "totality of circumstances" an analysis of the factual record. *Id.* Vaughan's motion is an inappropriate attempt to limit the scope of trial issues in a manner more appropriately raised in a motion for summary judgment. The motion *in limine* to exclude evidence of willfulness must be denied.

B. Infringement Under Doctrine of Equivalents

1. Vaughan's Arguments

Vaughan seeks to exclude testimony relating to infringement under the doctrine of equivalents. Vaughan argues Liquid Dynamics is subject to prosecution history estoppel due to an amendment made during the prosecution of the '414 patent that narrowed the limitation of a "substantially helical flow path." On appeal, the Federal Circuit stated "the narrowing amendments introduced during prosecution to overcome the application's obviousness in light of the prior art, however, may prevent Liquid Dynamics from using the doctrine of equivalents to claim any flows

that are not substantially helical." *Liquid Dynamics Corp. v. Vaughan Company, Inc.*, 355 F.3d 1361, 1369 (Fed. Cir. 2004). Further, the Federal Circuit recognized:

> Liquid Dynamics presumptively surrendered its rights to all flows that are not substantially helical, even if they perform the same function as a substantially helical flow. Liquid Dynamics may establish literal infringement of the '414 patent by showing a substantially helical flow, but it will have to overcome presumption of surrender to claim that any flow other than a substantially helical one infringes under the doctrine of equivalents.

Id., 355 F.3d at 1370 (internal citations omitted). Vaughan argues Liquid Dynamics cannot overcome this presumption of surrender because it cannot show the equivalent in question, a flow pattern that is not substantially helical, was unforeseeable at the time of the amendment. Vaughan contends the flow patterns alleged by Liquid Dynamics to be equivalent are encompassed by prior art because they are random, substantial volume-filling flows. These flow patterns were deemed unallowable in the original claims in view of the prior art that embraced those equivalents. Further, Vaughan contends the amendment requiring substantially helical flow was not merely tangential to the asserted scope of equivalents. The amendment requiring "substantial helical flow" was the essence of the invention and is the reason the claims were allowed. Finally, Vaughan argues Liquid Dynamics cannot provide a convincing reason the presumption of prosecution history estoppel should not apply,

and Liquid Dynamics' decision to narrow the claims to only "substantially helical flow" is a classic example of surrender.

2. Liquid Dynamics' Arguments

In response, Liquid Dynamics argues the '414 patent's prosecution history explicitly demonstrates it did not intend to surrender any substantially volume-filling flows except those resulting in the "teacup effect." The teacup effect causes solid components to accumulate on the bottom of a tank when the contents are simply rotated. Liquid Dynamics states the prosecution history illustrates claim language was added to clarify that it was *not* claiming an arrangement of flow-generating devices resulting in flow directions that caused the teacup effect. The prosecution history emphasized the counter-teacup flow direction of the invention was being claimed, not any specific flow path. Therefore, the only territory surrendered, if any, included flow paths resulting in the teacup effect. Because the surrender of equivalents issue was not before the Federal Circuit, it did not analyze the prosecution history to address whether the presumption of surrender had in fact been rebutted and its comments regarding surrender were *dicta*. Liquid Dynamics argues it is able to rebut the presumption of surrender.

First, Liquid Dynamics asserts all teacup countering flows were not foreseeable. Foreseeability depends on underlying factual issues; by arguing Liquid Dynamics should be precluded from presenting any evidence as to what one of ordinary skill in the art would have considered foreseeable, Vaughan improperly seeks summary judgment on the issue. Further, the prosecution history shows the reason for the

amendment was tangential to the asserted equivalent because the amendment was clarifying not narrowing. The inventors amended the claims to better define the flow direction to counter the teacup effect; teacup-countering flow was not shown by the prior art. Finally, because of the shortcomings of language, the inventors could not describe all potential equivalent teacup-countering flows in the claims.

3. Findings

A patent holder is protected from efforts of copyists to evade liability for infringement by making only insubstantial changes to a patented invention. *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 535 U.S. 722, 726 (2002). "The scope of a patent is not limited to its literal terms but instead embraces all equivalents to the claims described." *Id.* at 732. When the extension of protection beyond the literal terms of the patent results in an unclear range of equivalents, however, competitors may not be able to determine what is permissible and what infringes. *Id.* at 726. Therefore, competitors may rely upon prosecution history. When the patentee narrows its claims to fix a rejection by the patent and trademark office, it is estopped from claiming the original, broader claim was an equivalent. *Id.* Competitors may rely on the estoppel to ensure their inventions will not be found to infringe by equivalence. *Id.* "Where the original application once embraced the purported equivalent but the patentee narrowed his claims to obtain the patent or protect its validity, the patentee cannot assert that he lacked the words to describe the subject matter in question." *Id.* at 734. "The doctrine of equivalents is premised on language's inability to capture the essence of innovation, but a prior

application describing the precise element at issue undercuts that premise." *Festo,* 525 U.S. at 734-35. In other words, prosecution history estoppel prevents the doctrine of equivalents from recapturing subject matter surrendered during prosecution. *Catalina Mktg. Intl v. Coolsavings,* 289 F.3d 801, 813 (Fed. Cir. 2002).

The Federal Circuit, addressing *Festo* on remand, recognized the Supreme Court established a presumption that a narrowing amendment made for a reason of patentability surrenders the entire territory between the original claim limitation and amended claim limitation. *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.,* 344 F.3d 1359, 1365 (Fed. Cir. 2003). A patentee may overcome the presumption by showing: (1) at the time of the amendment, the equivalent was unforeseeable; (2) the rationale underlying the amendment bore no more than a tangential relation to the equivalent in question; or (3) there was some other reason suggesting the patentee could not reasonably have described the equivalent in question. *Id.* Accordingly, "the first question in a prosecution history estoppel inquiry is whether an amendment . . . has narrowed the literal scope of a claim. If an amendment was not narrowing, then prosecution history estoppel does not apply." *Id.* at 1366. If the alleged infringer shows the amendment was narrowing, the question becomes whether the reason for the amendment was a substantial one relating to patentability. If not, prosecution history estoppel does not apply. If so, it is presumed that the patentee surrendered all territory between the original claim limitation and the amended claim limitation. The patentee may rebut the presumption of total surrender by demonstrating it did not surrender the particular equivalent in question by using

one of the three methods outlined by the Supreme Court. *Id.* at 1366-67. If successful, prosecution history estoppel does not apply. If unsuccessful, prosecution history estoppel bars the patentee from relying on the doctrine of equivalents for the accused element. *Id.* at 1367.

Rebuttal of the presumption of surrender is a question of law to be determined by the court, not the jury. *Id.* The first question in prosecution estoppel inquiry is whether the amendments narrow the literal scope of the claim. Vaughan argues Liquid Dynamics has surrendered its rights to all flows that are not substantially helical. Liquid Dynamics argues the amendments clearly indicate the inventors' intent to claim the counter-teacup flow direction of the invention, not any specific flow path. This court previously reviewed the prosecution history on summary judgment and determined:

> The original application presented to the Patent and Trademark Office ("PTO") did not describe claim 1's substantial helical flow path. The PTO rejected the original application based on prior art U.S. Patents Nos. 4,332,484 and 2,552,281. In response, the patentee argued the substantial volume filling flow described in Figures 5 and 6 was possible only with their invention, not the prior art patents. The patentee *submitted an amendment that substantially narrowed the '414 patent's scope,* and expressly outlined the flow pattern currently elaborated in claim 1.

Liquid Dynamics, 2002 U.S. Dist. LEXIS 14102, at *15 (emphasis added). The amendments narrowed the scope of

the claim. The Federal Circuit reviewed this court's analysis of the prosecution history, explained that the original claim 1 referred only to a "flow" whereas the amended claim 1 required a "substantial helical flow path," and held the presumption of surrender had been established. *Liquid Dynamics,* 355 F.3d at 1364-65, 1369-70. Liquid Dynamics may therefore rebut the presumption of surrender using any of the three methods articulated in *Festo.*

In assessing the first method of rebuttal, whether an alleged equivalent was unforeseeable at the time of the amendment, a district court may hear expert testimony and consider other extrinsic evidence relating to the relevant factual inquiries. *Festo,* 344 F.3d at 1369. "By its very nature, objective unforeseeability depends on underlying factual issues relating to, for example, the state of the art and the understanding of a hypothetical person of ordinary skill in the art at the time of the amendment." *Id.* In *Festo,* the Federal Circuit determined factual issues existed relating to the objective unforeseeability of the two accused equivalents and remanded the case to the district court for determination of whether the equivalents would have been unforeseeable to a person of ordinary skill in the art at the time of the amendments. If Liquid Dynamics fails to meet its burden of rebutting the presumption of surrender under the second or third prongs, it may present factual evidence at trial regarding whether the accused equivalent, flow patterns that are not substantially helical, was foreseeable to a person of ordinary skill in the art at the time of the amendments.

Liquid Dynamics does not successfully rebut the presumption of surrender under the second scenario, whether

the rationale for the amendment bore no more than a tangential relation to the equivalent in question. Rebuttal under the second method should be discernible from the prosecution history record without the introduction of additional evidence except, when necessary, testimony from those skilled in the art as to the interpretation of that record. *Festo,* 344 F.3d at 1369-70. The original '414 patent application did not describe claim 1's substantial helical flow path; the flow pattern was described through subsequent amendments. A description of the substantially helical flow path, including its counter-teacup producing direction, cannot be considered tangential to the accused equivalent: flow patterns that are not substantially helical. On summary judgment, this court recognized the patent's helical flow path is central to the operation of the invention and the patent was narrowed to encompass a specific type of flow pattern central to the invention. *Liquid Dynamics Corp. v. Vaughan Co.,* No. 01 C 6934, 2002 U.S. Dist. LEXIS 14102, *27-28 (N.D. Ill. July 31, 2002).

Liquid Dynamics has met its burden of rebuttal under the third method. Assessment of the third rebuttal method, whether there is some other reason suggesting the patentee could not reasonably be expected to have described the equivalent in question, should be limited to the prosecution history record when possible. *Festo,* 344 F.3d at 1370. This third category is a narrow one, but it may be satisfied when there was some reason, such as the shortcomings of language, the patentee was prevented from describing the alleged equivalent when it narrowed the claim. *Id.* Liquid Dynamics asserts shortcomings of language prevented the inventors from describing every precise equivalent flow pattern,

therefore the prosecution history focused on teaching flows in a different direction to counter the teacup effect. Liquid Dynamics notes the prosecution history shows the amount of detail required to describe a flow path.

The court finds Liquid Dynamics has sufficiently articulated a reason the inventors could not have reasonably described the equivalent in question. Because it was impossible for the inventors to describe all teacup-countering helical flows that might result from changing certain variables, the presumption of equivalents has been overcome. The motion *in limine* to exclude evidence of infringement under the doctrine of equivalents must be denied.

C-E. Unreliable Computer Simulations, Vector Plots and Expert Testimony Unhelpful to Trier of Fact

1. Vaughan's Motions

Vaughan's final three motions seek exclusion of expert testimony and testing. Vaughan argues Liquid Dynamics' CFD simulations do not meet minimum standards and controls as determined by the software's vendor and the relevant scientific community. Further, Vaughan asserts the simulations were performed hastily by an unskilled worker who received virtually no supervision from Lueptow. Consequently, Vaughan contends the results are not scientifically reliable and are inconsistent with independent testing. According to Vaughan, Lueptow fails to account for the discrepancies, and did not exercise the standard of care required in his regular academic work when performing the testing. Vaughan contends Fed. R. Evid. 702 requires

exclusion Lueptow's expert testimony because the opinion is based on unreliable data.

Vaughan also seeks to exclude vector plots attached to Lueptow's expert report. Vaughan contends the vector plots are two-dimensional "snap-shots" in the mixing cycle. According to Vaughan, these snap-shots are incapable of tracing the path of liquid or solid components because they lack the three-dimensional data necessary to predict the ultimate direction of flow. For instance, Vaughan asserts vector plots do not display out-of-plane components of velocity. According to Vaughan, out-of-plane components of velocity, however, often dominate the ultimate path of the particle. Vaughan argues several plots reflect zero or near-zero in-plane velocity. Accordingly, any velocity that might exist is out-of-plane and invisible on the two-dimensional plot. Vaughan contends the vector plots are misleading, and their probative value, if any, is outweighed by the potential prejudicial and confusing effect on the jury.

Finally, Vaughan seeks to exclude any expert opinion testimony that will not assist the trier of fact, including: (1) all opinion testimony of Edward Gillette concerning flow paths in the accused Vaughan systems; and (2) all opinion testimony of Gillette or Lueptow based upon CFD simulations. Vaughan asserts Gillette's opinions are speculative because they are not based on testing, observation or simulation of actual Vaughan installations. Vaughan contends Liquid Dynamics' CFD simulations were performed on computer models with tank geometries and flow parameters radically different from those of the accused Vaughan systems and are therefore unreliable. Vaughan

argues the testimony is therefore inadmissible under Fed. R. Evid. 702 because it will not assist the jury in determining the flow patterns of the Vaughan systems.

2. Evidence in Support of Vaughan's Motions

Liquid Dynamics submits a combined opposition to Vaughan's three motions *in limine* seeking exclusion of expert testimony and testing. The court first addresses Liquid Dynamics' arguments regarding the admissibility of evidence submitted in support of Vaughan's three motions.

Liquid Dynamics asserts that on May 1, 2002, the last day for disclosure of Rule 26(a)(2) rebuttal expert reports, Vaughan submitted a report signed by two employees, Dorsch and Keeran (the "Dorsch/Keeran report"). As previously discussed, Sections III and IV of the report are stricken as untimely expert opinion. The unstricken portions of the report opined on the validity of Lueptow's CFD simulations (Section I) and hypothetical alternative systems (Section II). Lueptow's testing and related testimony relates to the issue of infringement. Section I of the Dorsch/Keeran report addressed Lueptow's simulations in approximately four (4) pages of rebuttal opinion. To support its motions *in limine* challenging Lueptow's expert work and testimony, Vaughan submits two affidavits from Dorsch dated August 24, 2004 and August 26, 2004 that total 42 pages. Liquid Dynamics asserts the August 26th declaration submits new, untimely opinion testimony that: (1) Lueptow's CFD analysis is based on mixing tanks that "vary significantly in tank geometry, nozzle sizing, and nozzle placement from the actual, real world geometries and structures of the accused Vaughan

systems" (Dorsch Decl. at ¶¶ 4, 6-38); (2) critique Lueptow's CFD analysis (Dorsch Decl. at ¶¶ 39, 53-58, 60, 62-65, 68, 70-74, 76 and Attachment A); and (3) characterize the factual record (Dorsch Decl. at ¶¶ 77-87). Liquid Dynamics also argues the August 24th declaration submits new, untimely opinion testimony regarding vector plots. Dorsch Decl. at ¶¶ 2-6. Further, Liquid Dynamics contends Dorsch's new opinions rely on newly disclosed materials, specifically: (1) 32 pages of new CFD plots; (2) never disclosed portions of a CFX manual; and (3) publications from the American Institute of Aeronautics and Journal of Fluids Engineering that Vaughan never produced. Finally, Liquid Dynamics asserts Dorsch improperly relies upon deposition testimony from an employee of the CFX software distributor, Mr. Paul, that occurred on the last day of discovery and over a month after the May 2002 report.

Vaughan asserts Liquid Dynamics' objections to the contents of Dorsch's declarations confuse fact with opinion. Vaughan argues Fed. R. Evid. 702 and Fed. R. Civ. P. 26 anticipate an expert may testify in forms other than expert opinion, including statements of fact not within the realm of Rule 26(a) expert opinion. Vaughan asserts Dorsch's declaration does not offer a new opinion, rather it summarizes facts and reiterates opinions and conclusions set forth in the original Dorsch/Keeran report. In support of its response, Vaughan submits a third declaration from Dorsch addressing Liquid Dynamics' objections and asserting his prior two declarations did not set forth a new opinion.

The court has reviewed the May 2002 report and Dorsch's declarations. Vaughan's attempt to submit new

opinion testimony by calling it "fact" and trying to squeeze it under the parameters of generalized statements from the May 2002 report is appalling. The Dorsch affidavits are replete with inappropriate new opinions and the court will not attempt to recite it all here. As an example, however, Section I of the Dorsch/Keeran report states: "[nor solving large tank mixing problems . . . the tank and nozzle geometry must be constructed correctly . . . if a problem to be solved with CFX is set up improperly, the user will get an answer that is incorrect and that may not represent what actually happens in the real world." Dorsch/Keeran Rep. at 3. The report then broadly and generally identifies four weaknesses of Liquid Dynamics' CFD studies: (1) outlet boundary condition; (2) RMS residuals (3) use of 2nd order advection scheme; and (4) mesh refinement or inflation boundaries. *Id.* at 3-6. In contrast, Dorsch's August 26th declaration states specifics, such as "the mixing tanks modeled by Jared Proctor for each of the eight categories vary significantly in tank geometry, nozzle sizing, and nozzle placement from the actual, real world geometries and structures of the accused Vaughan systems." Dorsch Decl. at ¶ 7. The precise dimensions, parameters and other physical characteristics that create, in Dorsch's view, a "huge disconnect" between Liquid Dynamics' computer models and the actual tanks is provided for the first time. In doing so, Dorsch comments:

— The difference in nozzle diameter is "a very significant difference in light of what happens in the real world . . . a reduction in nozzle diameter has a big effect on the fluid velocity;" Dorsch Decl. at ¶ 10.

— "This is a problem for two reasons . . . the velocity assumed in the model is not just wrong but wildly wrong." The model "departs radically from the real world . . . a velocity and flow rate that could not physically be duplicated;" Dorsch Decl. at ¶ 12.

— "There are a great many parameters in this summary of so-called Group A systems that are missing. These missing parameters are not simply important, but critical, to creating a reliable computer model on which to simulate flow pattern . . ." Dorsch Decl. at ¶ 17.

Neither the elaborate description of the alleged physical inadequacies of the models, nor the conclusions Dorsch draws about their reliability were contained in the Dorsch/ Keeran report. The same is true with respect to the August 24th declaration critiquing Lueptow's vector plots. Indeed, the Dorsch/Keeran report did not even mention, let alone describe, vector plots. Further, the report did not identify Dorsch's reliance upon the challenged 32 pages of new CFD plots, never disclosed portions of the CFX manual and new publications.

Vaughan argues the declarations merely recite or summarize facts or reiterate opinions and conclusions disclosed in the report. Further, Vaughan argues factual, non-opinion statements of a witness are not subject to disclosure and Dorsch may testify to facts within his personal

knowledge. It is disingenuous for Vaughan to assert generalized statements in the Dorsch/Keeran report, such as "the tank and nozzle geometry must be constructed correctly . . . ," cover his elaboration more than two and a half years after the close of discovery.

Vaughan further argues the challenged CFD plots are not new information; rather, they display in graphic form: (1) results from simulations not discussed by Lueptow; (2) compilations of data produced by Liquid Dynamics evidencing Lueptow's lack of concern for his underling's work; and (3) summaries of streamline plots that could not have been generated at the time of the Dorsch/Keeran report. This is unacceptable. Expert reports must contain the data or other information considered by the witness in forming opinions, as well as any exhibits to be used as a summary of or support for the opinions. Fed. R. Civ. P. 26(a)(2)(B). Dorsch may not opine or offer "facts" to rebut the reliability of Lueptow's methods, models, data and conclusions beyond the original Dorsch/Keeran report. Failure to comply with Rule 26 precludes a party from using expert testimony that was not timely or fully disclosed. *Finley v. Marathon Oil Co.*, 75 F.3d 1225, 1230 (7th Cir. 1996). Vaughan's attempt to circumvent the requirements of Fed. R. Civ. P. 26(a)(2) must fail. The following new opinion testimony is disregarded: August 26th Declaration ¶¶ 4, 6-39, 53-58, 60, 62-65, 68, 70-74, 76-87 and Attachment A; August 24th declaration ¶¶ 2-6; newly cited portions of the CFX manual, and newly cited publications.

3. Disposition of the Motions

Even if the court did not disregard the challenged portions of Dorsch's affidavits, the remaining motions *in limine* would be denied. First, Vaughan's challenges to Liquid Dynamics' application of the CFD technology must fail. Fed. R. Evid. 702 provides the standard for admitting expert scientific testimony in a federal trial. *See Daubert v. Merrell Dow Pharmaceuticals, Inc.,* 509 U.S. 579 (1993). District courts are obligated to prevent unreliable expert testimony from admission. This obligation, however, does not include determination of whether the expert opinions are correct; rather the court's obligation is to examine the reliability of the expert's methodology. *Id.* at 593-96; *Quiet Tech. DC-8, Inc. v. Hurel-Dubois UK Ltd.,* 326 F.3d 1333, 1340-44 (11th Cir. 2003), *citing Kumho Tire Co., Ltd, v. Carmichael,* 526 U.S. 137, 153-54 (1999). The Supreme Court set forth five factors to guide a court in assessing the reliability of scientific expert testimony: (1) "whether a theory or technique . . . can be (and has been) tested;" (2) "whether the theory or technique has been subjected to peer review and publication;" (3) "the known or potential rate of error;" (4) "the existence and maintenance of standards controlling the technique's operation;" and (5) whether the technique or method has met with general acceptance. *Id.* at 593-94. The CFD methodology is not at issue. Courts have affirmed the reliability of CFD methodology. *See Quiet Tech. DC-8, Inc. v. Hurel-Dubois UK Ltd,* 326 F.3d 1333, 1343-44 (11th Cir. 2003); *Buckley v. Airshield Corp.,* 116 F. Supp. 2d 658, 661 (D. Md. 2000); *Flomerics, Ltd. v. Fluid Dynamics, Int'l, Inc.,* 880 F. Supp. 60, 61-63 (D. Mass. 1995). Vaughan does not dispute that CFD analysis is a reliable, scientific

methodology. Indeed, Vaughan's own experts conducted CFD analysis. Instead, Liquid Dynamics' application of that methodology is challenged. The application of a reliable methodology goes to the evidence's probative value, however, not admissibility. *Quiet* at 1343-46. Challenges addressing flaws in the expert's application of a reliable methodology should be raised on cross-examination. *Daubert,* 509 U.S. at 596 ("vigorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of challenging shaky but admissible evidence"); *see also Quiet,* 326 F.3d at 1344-45.

Second, Vaughan's challenges to Lueptow's vector plots must fail. Vaughan challenged the admissibility of Lueptow's vector plots on appeal. In its opinion, the Federal Circuit noted Vaughan's challenge to the vector plots' reliability, yet held Liquid Dynamics' evidence might convince a jury the patent was infringed. *Liquid Dynamics,* 355 F.3d at 1369. In any event, Vaughan has failed to demonstrate the vector plots are unreliable and inadmissible for all purposes.

Finally, Vaughan's challenges to Gillette's testimony must fail. A witness may qualify as an expert by knowledge, skill, experience, training, or education. Fed. R. Evid. 702. Gillette's *curriculum vitae* illustrates he has extensive experience in the field of sanitary engineering. Gillette considered testing conducted by Lueptow and voluminous documentation to formulate his opinions. An expert may consider testing of another expert in formulating opinions. *Walker v. Soo Line R.R.,* 208 F.3d 581, 589 (7th Cir. 2000). Gillette's testimony is not inadmissible for all purposes.

Appendix G

Vaughan's motions *in limine* to exclude computer simulations, vector plots and expert testimony must be denied.

CONCLUSION

Liquid Dynamics' motions *in limine* to limit testimony of defendant's experts to properly and timely disclosed opinions, to exclude undisclosed and untimely expert testimony of Norcross and Bathija, and to exclude Sandler's testimony are granted in part and denied in part. Liquid Dynamics' motion *in limine* to exclude Breidenthal's testimony is granted. Liquid Dynamics' motion *in limine* to exclude reliance on prior art references and related testimony is denied. Defendants' motions *in limine* are denied.

September 30, 2004

ENTER:

s/ Suzanne B. Conlon
Suzanne B. Conlon
United States District Judge

Appendix G

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS

01 C 6934

Suzanne B. Conlon

LIQUID DYNAMICS

vs.

VAUGHAN CO.

ORDER

Plaintiff's motion to limit testimony of defendant's experts [159-1] is granted in part and denied in part. Evidence or testimony relating to Sections III and IV of the Dorsch/ Keeran report and new opinion testimony by Dorsch or Keeran regarding infringement or critiques of Luetow's CFD simulations beyond that disclosed in the Dorsch/Keeran report are excluded. Plaintiff's motion to exclude presentation of both Dorsch and Keeran as experts is denied as moot. Plaintiff's motion *in limine* to exclude expert testimony of Norcross and Bathija [160-1] is granted in part and denied in part. The parties shall not refer to Norcross' opinions in opening statements in questioning witnesses, or otherwise in the jury's presence without prior court authorization. Plaintiff's motion to limit Bathija's testimony is denied as moot. Plaintiff's motion to exclude testimony of Breidenthal [161-1] is granted. Plaintiff's motion to exclude testimony of Sandler [162-1] is granted in part and denied in part. Sandler's testimony will be heard by the court

outside the jury's presence. Counsel shall not refer to Sandler's testimony in the jury's presence. Plaintiff's motion to exclude reliance on prior art references and related testimony [163-1] is denied. Defendant's motions *in limine* [152-1], [155-1], [156-1], [157-1] and [ ] are denied. Plaintiff's renewed motion to strike untimely expert opinion [181-1], and defendant's motion for leave to file a reply [182-1], are moot. ENTER MEMORANDUM OPINION AND ORDER.

DATE: 9/30/2004

s/ Suzanne B. Conlon

APPENDIX H — ORDER OF THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT DENYING PETITION FOR REHEARING FILED JULY 11, 2006

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

05-1105, -1325, -1366, -1399

LIQUID DYNAMICS CORPORATION,

Plaintiff-Appellee,

v.

VAUGHAN COMPANY, INC.,

Defendant-Appellant.

ORDER

A combined petition for panel rehearing and for rehearing en banc having been filed by the Appellant, and the petition for rehearing, having been referred to the panel that heard the appeal, and thereafter the petition for rehearing en banc having been referred to the circuit judges who are in regular active service,

UPON CONSIDERATION THEREOF, it is

ORDERED that the petition for panel rehearing be, and the same hereby is, DENIED and it is further

Appendix H

ORDERED that the petition for rehearing en banc be, and the same hereby is, DENIED. The mandate of the court will issue on July 18, 2006.

FOR THE COURT,

s/ Jan Horbaly
Jan Horbaly
Clerk

Dated: 07/11/2006

Supreme Court, U.S.
FILED
06-508 OCT 10 2006
OFFICE OF THE CLERK

No. 06-

IN THE

Supreme Court of the United States

VAUGHAN COMPANY, INC.,

Petitioner,

v.

LIQUID DYNAMICS CORPORATION,

Respondent.

ON PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

SUPPLEMENTAL APPENDIX

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US005458414A

United States Patent [19]

Crump et al.

[11] Patent Number: 5,458,414

[45] Date of Patent: Oct. 17, 1995

[54] **METHOD AND APPARATUS FOR STORING AND HANDLING WASTE WATER SLURRIES**

[75] Inventors: **James M. Crump**, Elburn; **Bruce K. Doyle, Jr.**, St. Charles, both of Ill.

[73] Assignee: **Great Lakes Aqua Sales and Service, Inc.**, St. Charles, Ill.

[21] Appl. No.: **385,588**

[22] Filed: **Feb. 8, 1995**

Related U.S. Application Data

[63] Continuation of Ser. No. 275,922, Jul. 14, 1994, abandoned, which is a continuation of Ser. No. 879,602, May 7, 1992, abandoned.

[51] **Int. Cl.**[6] **B01F 5/10**

[52] **U.S. Cl.** **366/137**; 366/263; 366/292

[58] **Field of Search** 366/136, 137, 366/165, 173, 262–264, 292

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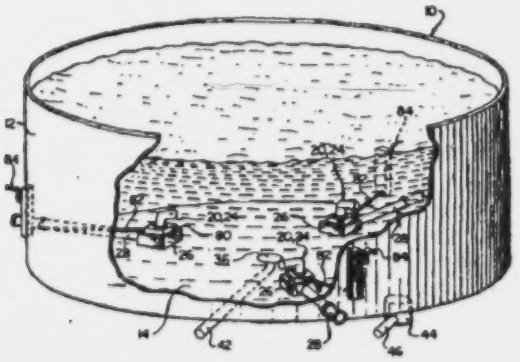
(List continued on next page.)

Primary Examiner—David Scherbel
Assistant Examiner—Terrence R. Till
Attorney, Agent, or Firm—Fitch, Even, Tabin & Flannery

[57] **ABSTRACT**

A method and apparatus for mixing solid and liquid components of a slurry which have settled in a storage tank, suspending the solids in a substantially homogeneous slurry mixture are practiced by directed flow apparatus. A plurality of jet nozzles or propeller mixers is located in the storage tank within an annular band ranging between 25 percent and 75 percent of the radial length from a center of the tank to a tank wall. They are directed either in a tangent direction or at an angle away from the center of the tank to provide a substantially volume-filling mixing flow to suspend the solid slurry component in the liquid slurry component.

11 Claims, 5 Drawing Sheets



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Trade brochure entitled "Penberthy Jet Pump Technical Data: mixing liquids," (Bulletin 1401), 4 pp., published by Penberthy, Div. of Stanwich Industries, Inc., Prophetstown, Ill., issue date Sep. 1987.

Biothane Corporation shop Drawing No. E–11898, "Digester Feed Distribution Piping", Rev. Mar. 2, 1988.

Biothane Corporation shop Drawing No. D–11901, "Feed Distribution Piping Details", Rev. Mar. 2, 1988.

FIG.1

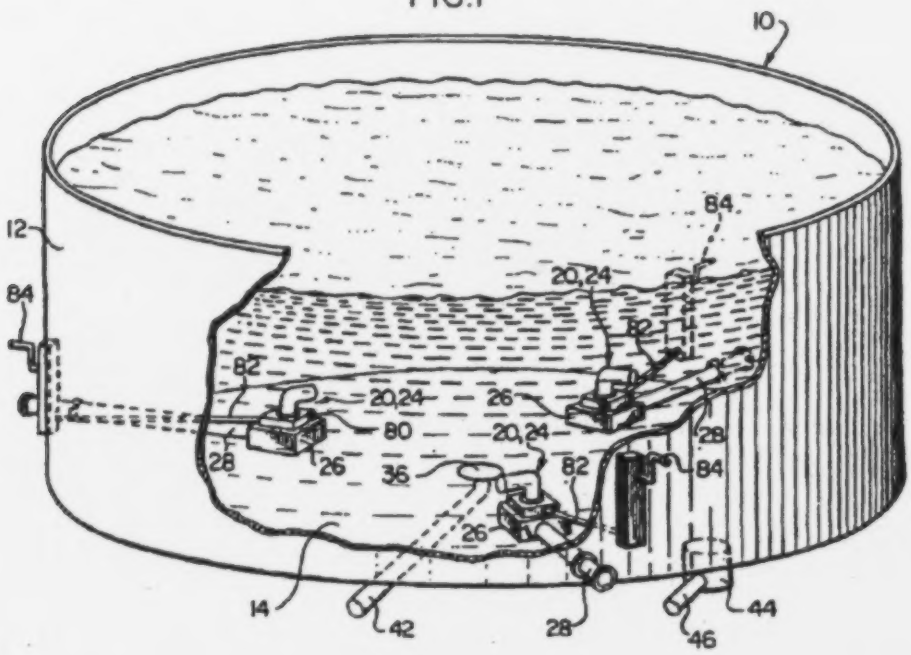


FIG.7

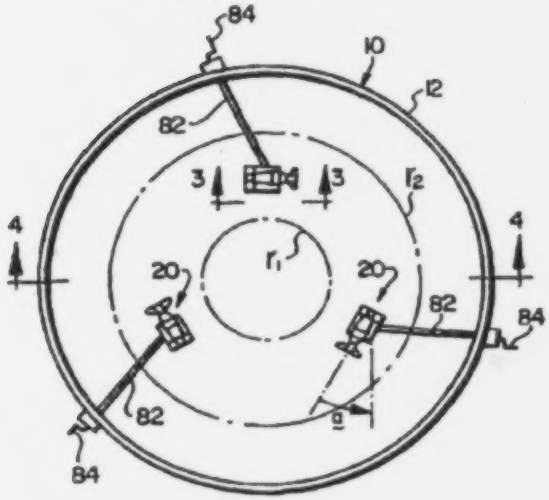


FIG.8

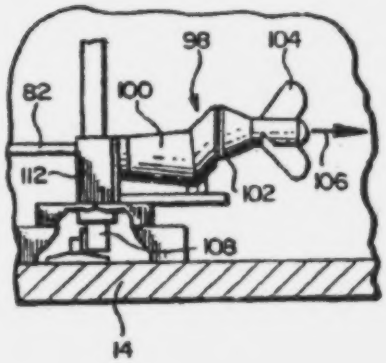


FIG. 9

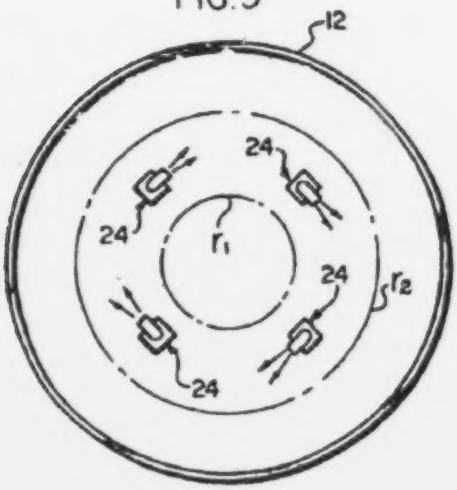


FIG. 10

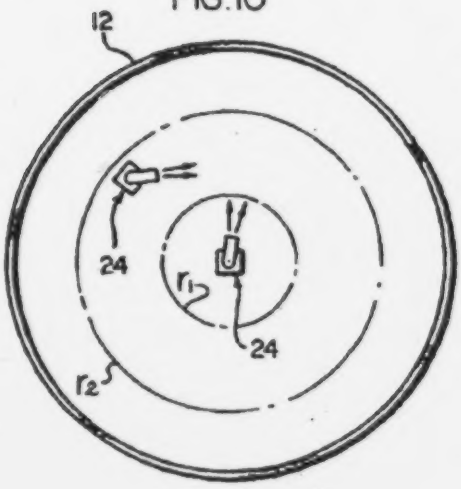
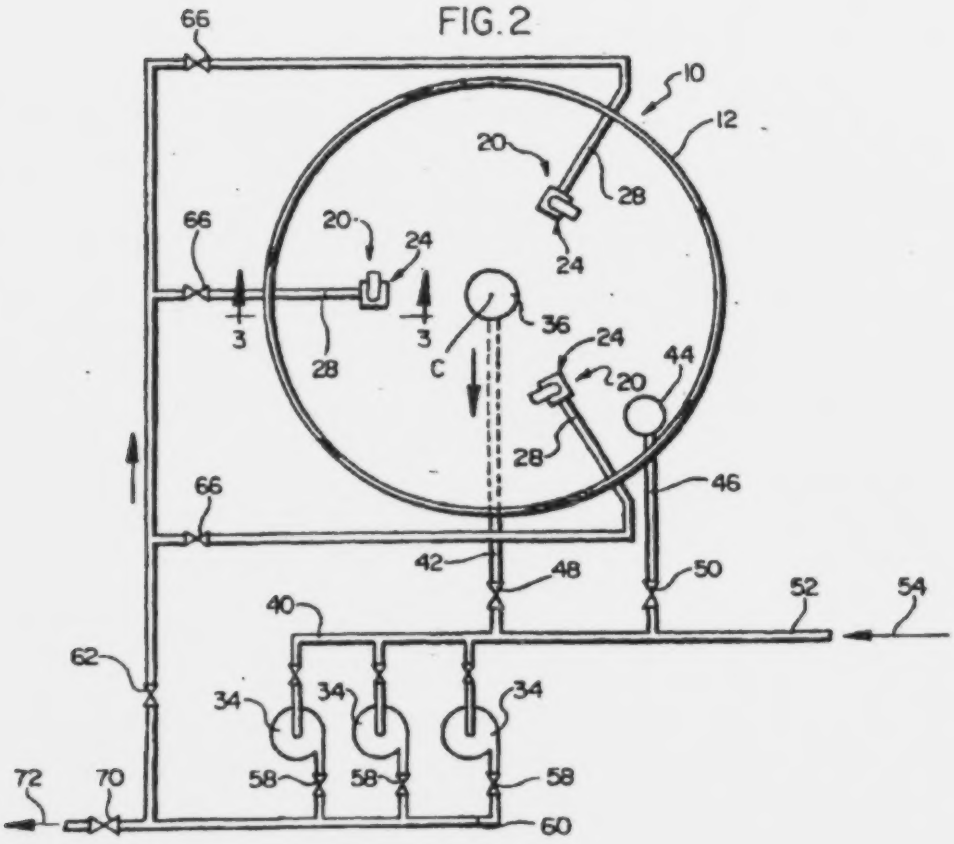


FIG. 2



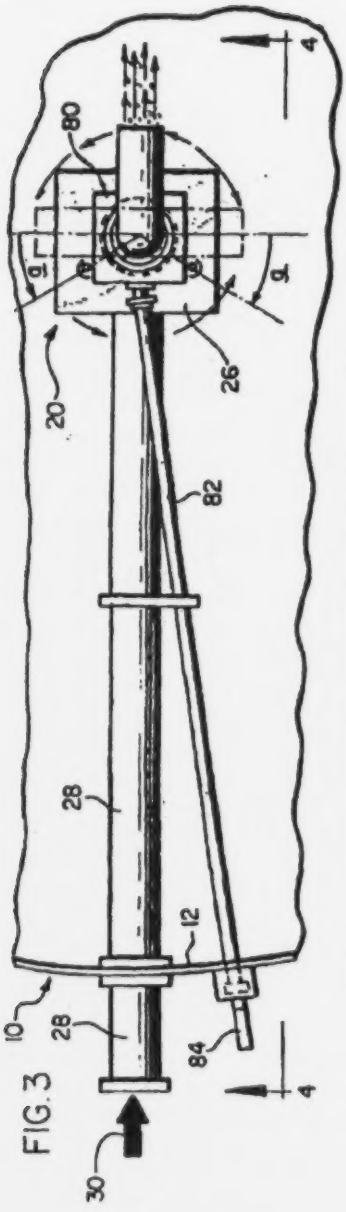


FIG. 3

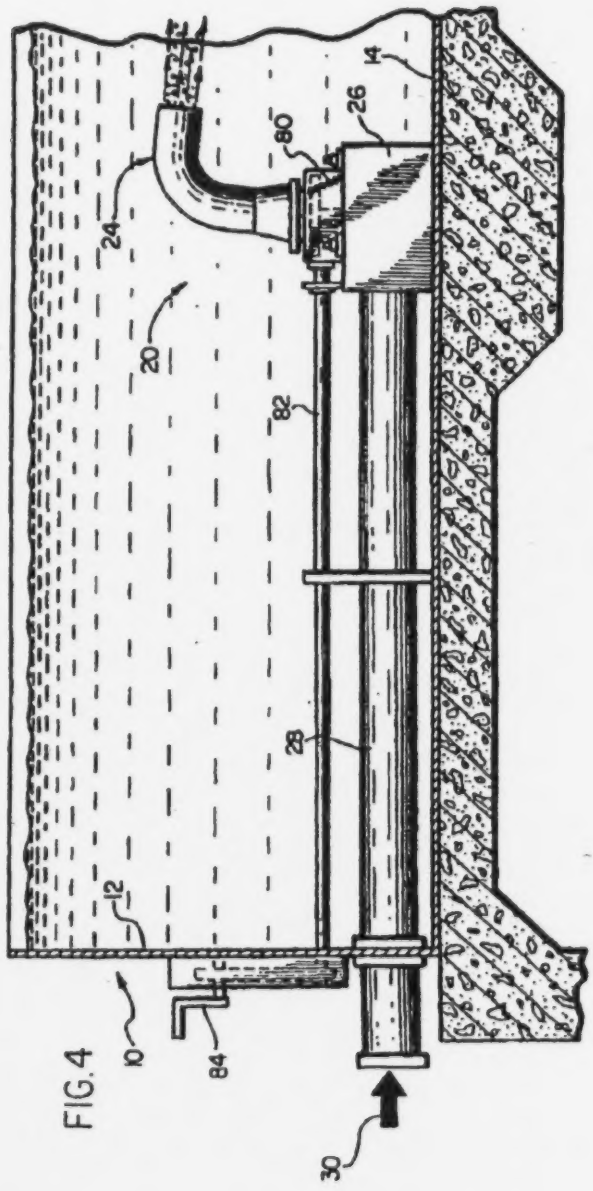


FIG. 4

FIG.5

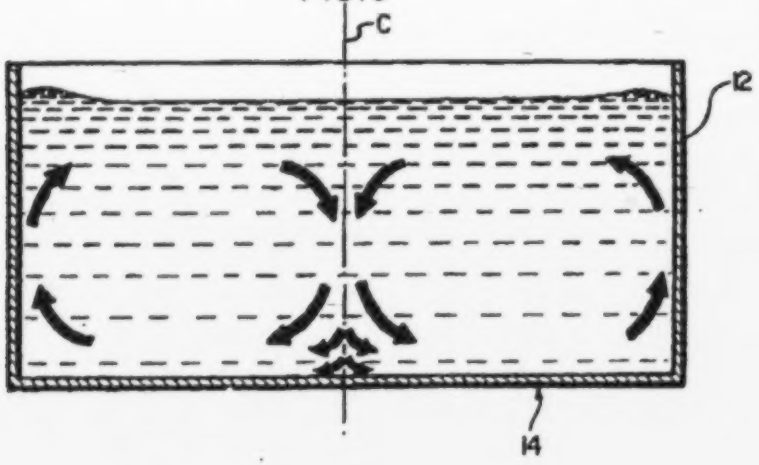


FIG.6

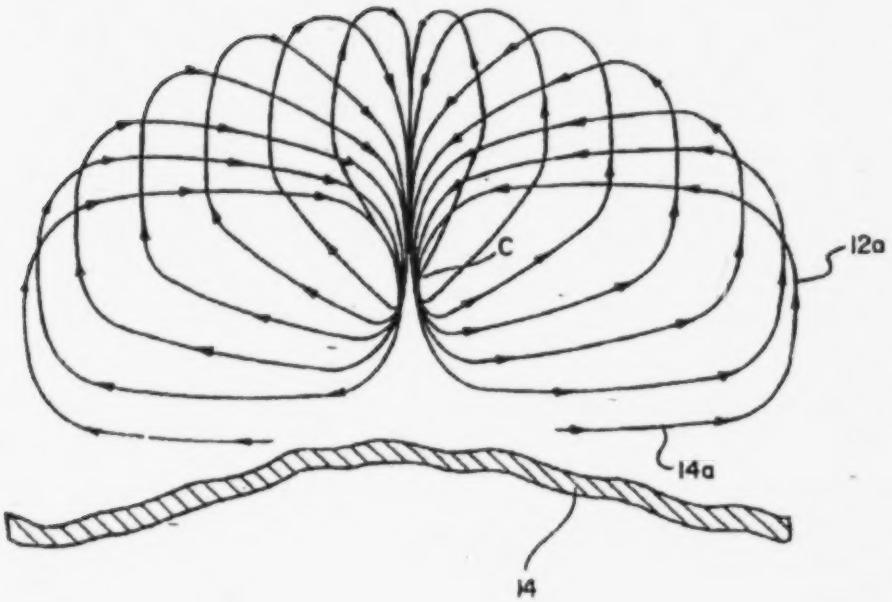


FIG.11
PRIOR ART

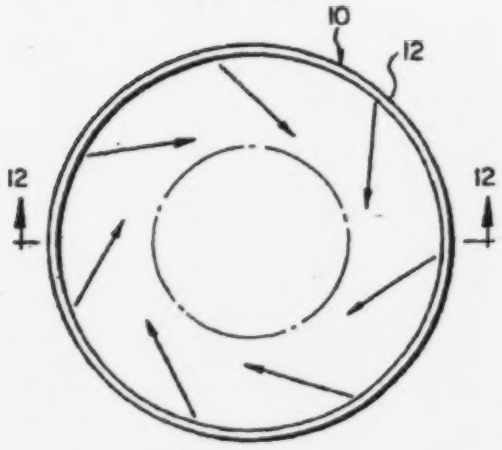


FIG.13
PRIOR ART

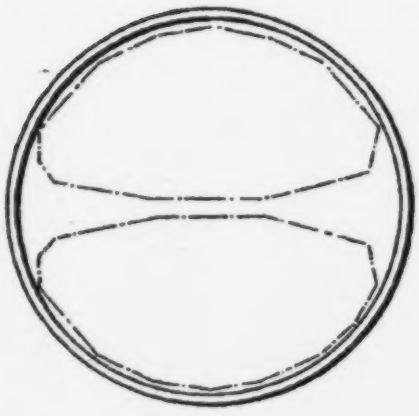


FIG.12
PRIOR ART

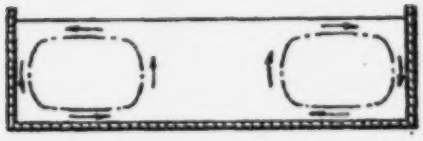


FIG.14
PRIOR ART

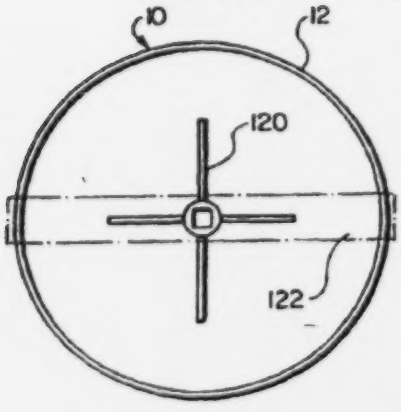
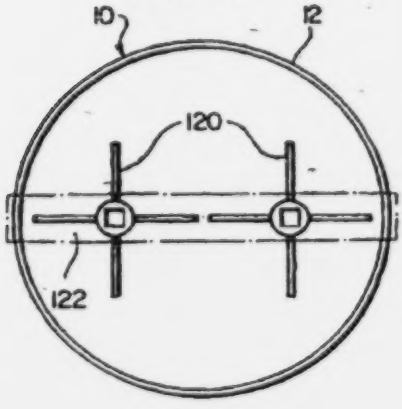


FIG.15
PRIOR ART



METHOD AND APPARATUS FOR STORING AND HANDLING WASTE WATER SLURRIES

This application is a continuation of application Ser. No. 275,922 filed Jul. 14, 1994, now abandoned, which is a continuation of application Ser. No. 879,602 filed May 7, 1992, now abandoned.

BACKGROUND OF THE INVENTION

The present invention pertains to waste treatment facilities in general, and in particular to long-term storage of slurries.

Liquid sludge storage has been used for agricultural applications. Typically, manure from livestock is stored over a period of time, until conditions are appropriate for land application or other disposition of the stored material. It has been found convenient to store the manure in a liquid form in large open top storage tanks. As those skilled in the art will readily appreciate, the manure, which is fed into the tank in the form of a liquid/solids slurry, will begin to settle and a surface crust will start to form in a relatively short time after introduction in the storage tank. After relatively long storage times, up to six months or more, the contents of the tank must be discharged for application in a field. Due to the settling, and crust formation on the top of the tank, preparations must be made several days ahead of time to prepare the tank contents for discharge using liquid handling devices.

In waste water treatment facilities, such as municipal waste water treatment plants, sludge is processed in various liquid forms and then stored in a dried condition. However, due to environmental considerations, difficulties in handling the sludge during treatment, and other factors, there is a growing interest in storing the sludge in a liquid form.

When liquid sludge storage has been practiced in the past, the contents being stored have been continuously mixed to maintain the sludge solids in suspension. This facilitates withdrawal of sludge with relatively little preparation using liquid handling systems. However, when sludge is stored for a prolonged period of time, on the order of several months or more, the costs of maintaining sludge in a slurry form can be significant. Accordingly, there has been a recent emphasis in exploring cost savings by allowing sludge slurries in long-term storage to settle, and to mix the contents of the storage tank only prior to tank unloading.

As those skilled in the art will appreciate, a crust of substantial thickness can form on the surface of the tank and settling of solid sludge components can be quite pronounced, requiring appropriately distributed mixing energy to be applied to the tank contents so as to complete re-suspension of the solid contents of the tank. It has been found that submerged mixing devices, either of the propeller or gas type, have not been able to effectively mix tanks of larger diameter size particularly when re-suspension of solids is necessary. Fixed propeller-type mixers, either those entering the side or top of the tank provide a substantial mixing energy to the tank contents, but have been found to leave dead spots in the tank which are not mixed. Also, propeller mixers have been found effective only at certain specified water levels.

Diffused aeration systems have been used successfully on some types of mixtures, but have not been capable of re-suspending solids which have settled out of a slurry mixture, and are thus unsuitable for use with long-term sludge storage. U.S. Pat. No. 3,271,304 provides an example of a diffused aeration system.

Fixed liquid jets have been installed in storage tanks, and have been found to create a velocity sufficient to maintain solids in suspension and to re-suspend solids in the flow path. However, in practical applications, portions of the tank, oftentimes the center of the tank bottom, have been found unmixed. Also, fixed liquid jets as previously employed, have not been able to break up a crust formed on the top of the storage tanks. U.S. Pat. No. 3,586,294 shows an example of fixed liquid jets. The jets are fed from a header system located at the bottom of the storage tank, and produce counter-rotating flows. U.S. Pat. No. 4,416,549 discloses an arrangement for mounting a pump at the bottom of a storage tank, and includes a mounting arrangement for attachment to the outer wall of the tank.

Pivoting propeller mixers have been installed along tank sidewalls. In general, pivoting propeller mixers have been able to generate velocities necessary to re-suspend solids along the outer portion of the tank, but contents at the center of the tank have not been re-suspended.

Certain improvements have been provided by the arrangement of U.S. Pat. No. 4,332,484 which employs a rotatable liquid jet nozzle located at the center of a storage tank. A second nozzle is located above the water level of the tank and is manually directed to break up the top crust which forms on the tank, and to clean off the tank walls after the tank has been emptied. The centrally located rotatable nozzle is positioned adjacent the tank floor and applies velocity at a point where solids are accumulated.

In order to break up the crust formed at the upper surface of the tank contents, U.S. Pat. No. 4,512,665 provides an adjustable nozzle mounted at the top of the tank for discharging a flow downwardly on top of the crust to break up the crust in preparation for homogenization of the crust pieces by other systems.

SUMMARY OF THE INVENTION

It is an object according to the present invention to provide method and apparatus for improved mixing of slurries, in particular waste water slurries or manure slurries in storage tanks.

Another object according to the present invention is to provide method and apparatus of the above-described type which provides an improved energy distribution of an agitating flow generated in a storage tank.

Yet another object according to the present invention is to provide methods and apparatus for agitating the contents of a sludge storage tank to suspend settled solids, and also to break up crusts which form on the tank contents, and a related object is to provide these advantages with a minimum number of submerged flow generating units without requiring mixing units generating flows outside of the tank contents.

These and other objects according to the present invention which will become apparent from studying the appended description and drawings are provided in apparatus for storing a slurry having solid and liquid components, comprising a storage tank defining a volume for holding the liquid and solid slurry components, including a floor of generally circular configuration and having a center portion, the storage tank further including an outer surrounding wall positioned generally at a preselected radial distance from the center portion, and at least two flow generating means positioned to be submerged within the liquid and solid slurry components for generating flow of at least one of the slurry

components along a preselected direction, the flow generating means being disposed only at distances from the center portion ranging between approximately 25 percent and 75 percent of the preselected radial distance the flow generating means creating a substantially volume filling flow of at least one of the slurry components within the storage tank which mixes the liquid and solid slurry components to form a substantially homogenous slurry suitable for unloading from the storage tank using liquid handling devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, shown partly cut away, of apparatus according to principles of the present invention;

FIG. 2 is a top plan view thereof in schematic form;

FIG. 3 is a fragmentary view taken along the line 3—3 of FIG. 2 shown on an enlarged scale;

FIG. 4 is a cross-sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is a diagrammatic view showing the flow pattern within the tank;

FIG. 6 is a diagrammatic perspective view of the flow pattern;

FIG. 7 is a top plan view of an alternative embodiment;

FIG. 8 shows a fragmentary portion of FIG. 7 in elevation, on an enlarged scale;

FIGS. 9 and 10 are top plan views of other alternative embodiments;

FIG. 11 is a diagrammatic plan view of a prior art system;

FIG. 12 is a cross-sectional view taken along the line 12—12 of FIG. 11; and

FIGS. 13–15 are top plan views of prior art systems.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1–6, a first embodiment of an apparatus 8 according to principles of the present invention is shown. The apparatus 8 includes a storage tank 10 of generally cylindrical, open top construction, for holding a wide variety of materials, especially slurries having liquid and solid components. The present invention has found immediate commercial acceptance for holding liquid sludge of the manure slurry, and especially the waste water treatment types. Storage tank 10 has an upstanding wall 12 and a circular floor 14, preferably of flat, generally horizontal construction. The storage tank 10 is preferably of cylindrical form, but can have other configurations such as sidewalls having multiple, non-continuous side portions (such as an octagon, for example) and the floor 14 could be of slightly conical configuration with the tip of the cone pointing either upward or downward. The storage tank 10 is preferably constructed above ground, but can also be constructed below grade, if desired.

Disposed within the storage tank 10 is a plurality of flow generating means comprising flow devices of the type having directed flow output. The flow devices can have any form are positioned within the storage 10 to be partly or wholly submerged in at least one of the liquid and solid components of the slurry. The flow devices 20 direct output flow generally along a line or over a relatively narrow angle of dispersion, at least at the outputs of the devices. Flow devices of the preferred embodiments are of the jet nozzle or discharge nozzle type and the propeller mixer type. FIGS. 1–6 show an embodiment of three jet nozzle or discharge nozzle units 20, while FIGS. 7 and 8 show flow devices of the propeller mixer type. In the first preferred embodiment, the jet nozzle units 20 have portions that are rotatable in generally horizontal planes so as to change the direction of directed flow output from the units, as will be explained herein. With additional reference to FIGS. 3 and 4, the jet nozzle units 20 each include a jet nozzle or discharge nozzle, generally indicated at 24, and include an inlet connection 26, preferably in the form of a housing mounted to the circular tank floor 14. The inlet connection 26 is coupled through a pipe 28 to a suitable source of high pressure flow indicated by arrows 30 in FIGS. 3 and 4. The pipe 28 extends through the wall 12 of the storage tank 10 to facilitate maintenance or modification of the high pressure source 29. Referring to FIG. 2, one example of the high pressure source 29 is illustrated as including a plurality of pumps 34, preferably of a comminuting or chopping type, receiving flow from a center sump 36 located within the storage tank 10 and coupled to a header 40 by a pipe 42. An optional second or peripheral sump 44 is coupled to a header 40 by a pipe 46. A pair of valves, respectively numbered 48 and 50, control flow into the header 40. The header 40 includes an inlet portion 52 for receiving a flow of makeup water, schematically indicated by arrow 54, which can be used to add water or other fluid to the storage tank 10, as desired. Each pump 34 has associated with it a valve 58 coupling the pump 34 to an outlet header 60. A valve 62 couples the outlet header 60 to the inlet connections 26 through the pipes 28. Flows to each of the inlet connections 26 are controlled by respective valves 66.

Discharge of the slurry components from the storage tank 10 may be accomplished in a number of different, suitable ways. For example, a valve 70 allows discharge in the direction of an arrow 72. It may be desirable during such discharge that the valve 62 be closed to route maximum pumping power through the valve 70 so as to direct the slurry components through piping or to vehicles for further processing or disposition at a remote location.

In the preferred embodiment, a closed loop flow-through mode of operation is employed for mixing and suspending the slurry components with the slurry components being withdrawn from the storage tank 10 via the center sump 36 and the peripheral sump 44 in the storage tank 10 and directed through the manifolds and the pumps 34 to be returned to the storage tank 10 through the jet nozzles 24.

Referring again to FIG. 1 and to FIGS. 3 and 4, the jet nozzle units 20 further include devices for changing the direction of flow by positioning the jet nozzles 24, which are preferably in the form of a gear box 80 mounted atop the inlet connections 26 and driven through transmission shafts 82 by manually operated cranks 84 located outside of tank 10. The jet nozzle units 20 are preferably of a type disclosed in U.S. Pat. No. 4,332,484 (herein incorporated by reference) and commercially available from A. O. Smith, as part of its Slurrystore sludge storage systems. As indicated in FIG. 3, the jet nozzles 24 may be continuously rotated and such is helpful for cleaning the storage tank 10 after the contents have been removed. However, it is generally preferred during operation when contents of the storage tank 10 are being re-suspended into a homogeneous composition, that the jet nozzles 24 be directed away from the tank center, being operated throughout an acute angle a ranging between 0° and 60° as measured from a line perpendicular to a radius from the center C of the storage tank 10, and extending through the flow device 20.

As indicated in FIGS. 1 and 2, for example, it is generally preferred that all jet nozzles 24 of a system are all directed

in the same rotational sense. For example, as can be seen in FIG. 2, an overhead plan view, the jet nozzles 24 are all directed in a clockwise direction. FIG. 2 shows the jet nozzles 24 all directed along tangent lines, although as mentioned above, the jet nozzles 24 can be angled slightly outwardly away from the tank center C and as will be seen herein, a surprising improvement in mixing the center of the storage tank 10 is achieved even though the jet nozzles 24 are angled away from, rather than toward, the tank center C.

As can be seen in FIG. 2, the jet nozzles 24 are located at equal radial lengths from the tank center line C. According to an important aspect of the present invention, the jet nozzles 24 are located within an annular band ranging between 25 percent and 75 percent, and more preferably between 30 percent and 70 percent of the radial distance from the tank center C to the tank wall 12. Multiple "rings" of jet nozzles 24 can be employed within the annular band, or less preferably, the jet nozzles 24 can be located at varying distances from the tank center C. Although the preferred tank configuration is cylindrical, the present invention may also be adapted for use with slightly out-of-round tanks, as well as with octagonal and other multi-sided tanks, in which case the aforementioned annular band is measured with respect to a "radius" corresponding to the average distance between the center of the tank and the tank wall sides.

As shown in the figures, the flow devices, whether of the propeller type or jet nozzle type, are all located at equal radial lengths, although the flow devices of any one particular system could be located at different radii falling within the aforementioned annular band. Further, the figures show the flow devices all point in the same direction with respect to tangents to the flow device radius, although the flow devices could point in different directions, and such may be desirable for certain tank sizes and aspect ratios. However, it is preferred that the flow devices have directed outputs ranging within the limits of angle a, as described above.

Further, the flow devices illustrated in the figures are all equally spaced and, while such is the preferred arrangement, the flow devices could be unequally spaced for tanks of certain size and aspect ratios. For example, flow devices may be grouped in pairs of differently directed devices, and such is contemplated by the present invention. Other alternative arrangements will become apparent upon studying the description and drawings.

Referring now to FIGS. 5 and 6, arrangements of submerged flow devices within the annular band described above, have been found to produce surprising results including substantially volume-filling flow which has been found to maintain suspension and even more surprisingly, remix into homogeneous suspension substantially the entire contents of the tank. Notably, the present invention has been found to thoroughly maintain in suspension and if necessary, remix contents located at the center line C of the storage tank 10. As illustrated in FIG. 5, flow is directed along the outside wall 12 of the storage tank 10, across the surface of the slurry components in the storage tank 10 and downwardly along the tank center C. The flow then sweeps across the tank floor 14, especially at the point where the vertical center line C intersects the tank floor 14. Further, flow produced according to principles of the present invention is believed to be substantially helical, sweeping out an annular volume having a negligible central radius and an outer radius corresponding to that of the tank wall 12, as illustrated in FIG. 6. The flow lines of FIG. 6 include flow components 14a travelling across the tank floor 14, and flow components 12a sweeping along the tank wall 12, and returning downwardly at the center C of the storage tank 10. The resulting flow patterns create an intensive mixing at the center of tank by creating a vortex-like characteristics therein. In some cases a true vortex is created at the tank center, depending upon the viscosity of the slurry and/or its components.

As mentioned, the present invention, with submerged flow devices located in the annular band defined above, provides surprisingly thorough mixing of tank contents, even slurry compositions which have heretofore been difficult to handle. Examples of such slurry compositions contemplated by the present invention are manure solutions, waste water and waste slurries for industrial plants. The slurries also comprise those processed by water treatment plants, including municipal water treatment plants and municipal and/or industrial waste water treatment plants. Quite surprisingly, the present invention dramatically reduces the time required to remix i.e., re-suspend slurries which have settled over prolonged storage periods, on the order of several months or more. As those skilled in the art will appreciate, it has been difficult, heretofore, to completely mix manure storage tanks which have been allowed to settle over prolonged periods of time, using only submerged flow devices. Difficulties have been encountered in suspending solids which have accumulated on the tank floor, especially near the center of the tank floor. The present invention provides an energy distribution which accomplishes re-suspension of solids at the center of the tank floor, in a surprisingly short time.

Further, those skilled in the art readily appreciate that waste water tanks and manure slurry storage tanks form crusts of substantial thickness and mechanical strength when tank contents are allowed to settle, without continuous agitation over prolonged periods of time. The formation of such crusts, along with difficulties in remixing solids at the tank floor have heretofore prevented manure and waste water storage systems which do not require energy input during prolonged storage periods. With the present invention, crusts even those of substantial thickness associated with prolonged storage periods, are broken up and suspended into a substantially homogeneous slurry in a surprisingly short time. With the present invention, the crusts formed on such tanks, even over prolonged periods on the order of 6 months, (e.g., crusts having a thickness of six inches or more) are completely re-suspended into a homogeneous slurry in times as short as two days, with flow rates as flow as 3 to 5 lineal feet per second. In the prior art, minimum energy levels of 50 to 75 brake horsepower per 1,000,000 gallons of tank volume were required to turn over the contents of the tank volume. In the present invention, the same results can be achieved using as little as 25 to 30 brake horsepower per 1,000,000 gallons of tank volume.

Referring now to FIGS. 7 and 8, an alternative embodiment is shown using a different type of flow device, preferably comprising conventional propeller mixers 98 of the type commercially available from Flygt Corporation and others. The preferred propeller mixers 98 are of the submerged motor type, and include drive motors 100 and transmissions 102 driving a propeller blade 104 mounted about an axis of rotation generally aligned with the direction of flow output indicated by arrow 106 in FIG. 8. The propeller mixers 98 preferably include a pivoting mounting 108 extending in a generally vertical direction so that the propeller directed output may be swung about a horizontal plane. The propeller mixers 98 further include a gear box 112 driven by transmission shaft 82. Because of the electrical connections to the drive motors 100, it is generally preferred that the propeller mixer's rotation be limited to

avoid the need for rotatable wiping contacts for the electrical connections. As with the preceding embodiment, it is preferred that the propeller mixers **98** be rotatable away from the tank center over an acute angle a ranging between 0° and 60° as measured with respect to a line normal to the radius passing through the propeller mixer device. As with the jet nozzle units described above, the propeller mixers produce a directed flow, or pressurized output stream directed along an axis line, at least in areas located at the mixer output. It is generally preferred that the outputs of the flow devices have a relatively small dispersion angle so as to provide the defined flow paths described above with reference to FIGS. **5** and **6**, for example. Propellers driven by motors located outside of the slurry may also be used. If desired, the flow devices used with the present invention can be fixed, i.e., not rotatable.

Referring now to FIG. **9**, a further alternative embodiment according to principles of the present invention will be described. Thus far, the mixing arrangements have consisted of groupings of three flow devices. In FIG. **9**, four flow devices are employed to produce the flow patterns described above with reference to FIGS. **5** and **6**, for example. The flow devices illustrated in FIG. **9** are of the jet nozzle type, but also could be of the propeller mixer type, if desired. The jet nozzles **24** are located along a common radius, are pointed with the same rotational sense and are spaced equidistant from one another although, as mentioned above, other arrangements differing from that illustrated are also possible. FIG. **9** indicates the aforementioned annular band within which the flow devices are located. In FIG. **9**, the annular band has an inner limit r_1 and an outer limit r_2 ranging between 25 percent and 75 percent, and more preferably between 30 percent and 70 percent of the radial distance to tank wall **12**.

Referring now to FIG. **10**, a further alternative embodiment is illustrated using two flow devices, such as jet nozzles **24**. In FIG. **10**, one jet nozzle **24** is located at the center of the storage tank **10**, while the second jet nozzle **24** is located within the annular band defined by principles of the present invention. FIG. **10** shows a minimum number of flow devices required to produce the flow patterns described above with reference to FIGS. **5** and **6**, for example. The jet nozzle **24** located in the annular band may have to be pointed slightly toward the tank center C as illustrated, for some tanks, although it is generally preferred that it be pointed away from the tank center for most applications.

Referring now to FIGS. **11** and **12**, a prior art flow pattern is schematically indicated for tank mixing systems having flow devices located adjacent a tank wall **119**. An example of such an arrangement employs propeller mixers mounted to the tank wall **119** for stabilization and ready maintenance. One problem encountered with such an arrangement is that the center of the tank, that area located within the dot-dash inner circle of FIG. **11**, experiences greatly diminished and oftentimes negligible mixing. An increase in the number and power of the mixing units has not been found effective in overcoming the observed difficulties in thorough mixing, which alone are provided by systems according to principles of the present invention.

FIG. **12** shows a cross-sectional view of flow through the tank in which the unmixed central core of the tank is evident. Thus, although substantial amounts of flow energy are imparted to the contents of the tank, the energy is not distributed as in the present invention and as a result, solids accumulate at the tank center.

FIG. **13** shows another flow pattern experienced with prior art mixing systems, again showing a non-uniform energy distribution, and flow patterns which are not substantially volume-filling as in the present invention. In FIG. **13**, the flow patterns are limited to two lobes separated from one another by a strip of poor or negligible mixing. The flow pattern of FIG. **13** may result from the dual paddle mixer arrangements schematically indicated in FIG. **15**. In FIG. **15**, a pair of paddle assemblies **120** is located on an overhead suspension member **122**, stretching across the top of a storage tank **123**. FIG. **14** shows a single paddle mixer which also has been found inadequate to mix tank contents, particularly at portions of a tank floor adjacent the tank wall **125**.

As can be seen from the above, the present invention employs flow devices, submerged or not, having submerged directed flow outputs, which are located within an annular band located between 25 percent and 75 percent and most preferably between 30 percent and 70 percent of the radial distance from the center of the storage tank to the tank outer wall. The annular band may also be determined for non-cylindrical tank walls having multiple sides of uniform construction, such as octagons, hexagons and the like or out-of-round configurations. The directed flows from the flow devices are preferably angled within an acute angle directed away from the tank center, the angle being measured with respect to a tangent to the flow device radius. The acute angle ranges between 0° (i.e., normal to the tank radius) and 60°, and varies for tanks of differing sizes and aspect ratios. It is preferred that flows according to principles of the present invention be set up so as to have downwardly directed components at the center of the tank, although upwardly-directed components at the tank center are also possible and are contemplated by the present invention.

It is preferred that the flow devices be located at generally the same height with respect to the tank floor. However, the various flow devices of a system may be installed at differing heights, if desired.

While it is generally preferred that the same type of flow device, preferably either a propeller mixer or jet nozzle, be employed throughout a given system, the flow device types can be mixed in a given system if desired, and may be combined in pairs to achieve desired flow patterns.

The drawings and the foregoing descriptions are not intended to represent the only forms of the invention in regard to the details of its construction and manner of operation. Changes in form and in the proportion of parts, as well as the substitution of equivalents, are contemplated as circumstances may suggest or render expedient; and although specific terms have been employed, they are intended in a generic and descriptive sense only and not for the purposes of limitation, the scope of the invention being delineated by the following Claims.

What is claimed is:

1. Apparatus for storing a slurry having solid and liquid components, comprising:

a storage tank defining a volume for holding a body of liquid and solid slurry components, including a floor of generally circular configuration and having a center, said storage tank further including an outer surrounding wall positioned generally at a radial distance from the center;

at least two flow generating means positioned to be submerged within the liquid and solid slurry components for generating flow of at least one of the slurry components along a rotational direction, each of said

flow generating means being disposed at distances from the center ranging between approximately 30 percent and 70 percent of said radial distance;

each of said first and second flow generating devices pointed in the direction for generating flows of the liquid and solid components from the respective flow generating means directed in the same rotational sense, said first and second flow generating means being directed at an angle to the radius to generate flows with tangential components of flow to impart a rotational movement of the entire body of liquid and solid components;

each of said first and second flow generating means being pointed toward the outer surrounding wall for generating a substantial helical flow path of the liquid and solid components therein with the liquid and solid components traveling outwardly, across the tank floor from the center portion of the tank toward the tank wall and then upwardly along the tank outer surrounding wall to a first point and then inwardly along an upper portion of the body toward the center of the tank and then downwardly toward the tank floor, and then outwardly to a second point spaced circumferentially in the direction of rotation of the entire body of liquid, the liquid and solid components continuing to travel in the helical path as the entire body of liquid and solid components continues to rotate;

a pressure source coupled to the first and second flow generating means to generate directed streams from the flow generating means to rotate the body of liquid and solid components and to cause the flow in the helical path; and

said flow generating means creating a substantially volume filling flow of at least one of the slurry components within said storage tank which mixes the liquid and solid slurry components to form a substantially homogeneous slurry suitable for unloading from said storage tank using liquid handling devices.

2. Apparatus for storing a slurry having solid and liquid components as defined in claim 1 wherein one of said flow generating means comprises a discharge nozzle, the flow along the direction generated by said discharge nozzle comprising a jet stream of flow of at least one of the liquid and solid slurry components in the preselected direction.

3. Apparatus for storing a slurry having solid and liquid components as defined in claim 2 further comprising means for coupling said discharge nozzle to the pressure source.

4. Apparatus for storing a slurry having solid and liquid components as defined in claim 3 further comprising sump means coupled to said pressure source for directing at least one of the liquid and solid slurry components to said pressure source, to form a substantially closed loop path for circulating at least one of the liquid and solid slurry components within said storage tank.

5. Apparatus for storing a slurry having solid and liquid components as defined in claim 3 further comprising movable mounting means for movably mounting at least one of said flow generating means within said storage tank so as to selectively change the flow direction thereof.

6. Apparatus for storing a slurry having solid and liquid components as defined in claim 5 wherein said movable mounting means directs the flow direction of said flow generating means away from the tank center portion.

7. Apparatus for storing a slurry having solid and liquid components as defined in claim 1 further comprising a third flow generating means disposed within said storage tank for generating flow of at least one of the slurry components along a direction; and means for selectively controlling the discharge of said flow generating means.

8. Apparatus for storing a slurry having solid and liquid components and for mixing the solid and liquid slurry components to form a substantially homogeneous slurry, comprising:

a storage tank for holding a body of solid and liquid slurry components, said storage tank including a floor of generally circular configuration and having a center, said storage tank further including an outer surrounding wall positioned generally at a radial distance from the center; and

at least a first and a second flow generating means for submersion within the solid and liquid slurry components for generating flows of the solid and liquid slurry components along respective directions, said flow generating means each being located at a position in a range between less than 75 percent of said preselected radial distance from the center of said storage tank and greater than 25 percent of said radial distance from the center of said storage tank;

the first and second flow generating means being directed toward the tank outer surrounding wall and an angle to a radius of the tank to provide a substantial tangential flow to impart a rotational movement of the body of liquid and solid components;

a pressure source connected to the first and second flow generating means to generate directed streams from the flow generating means to generate a substantially helical flow path of liquid and solid components with the latter traveling outwardly across the tank floor, and then upwardly along the tank wall, and then along an upper portion of the body, and then inwardly toward the center of the tank, and then downwardly at the center portion of the tank and again outwardly toward a point on the tank wall spaced in the direction of rotation of the entire body to mix the solid and liquid slurry contents to form a substantially homogeneous slurry.

9. Apparatus for storing a slurry having solid and liquid components and for mixing the solid and liquid slurry components to form a substantially homogenous slurry suitable for unloading using liquid handling devices as defined in claim 8 further comprising movable mounting means for movably mounting said first flow generating means within said storage tank so as to selectively change the flow direction thereof.

10. Apparatus for storing a slurry having solid and liquid components and for mixing the solid and liquid slurry components to form a substantially homogenous slurry suitable for unloading using liquid handling devices as defined in claim 9 further comprising movable mounting means for movably mounting said second flow generating means within the storage tank so as to selectively change the flow direction thereof.

11. Apparatus for storing a slurry having solid and liquid components and for mixing the solid and liquid slurry components to form a substantially homogenous slurry suitable for unloading using liquid handling devices as defined in claim 10 wherein said movable mounting means directs the flow direction of said flow generating means away from the tank center portion.

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